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ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

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ZOOLOGY—VOL. XI.

PART XXXI.—REPORT ON THE KERATOSA.

BY N. POLÉJAEFF, M.A.

59.34

Published by Order of Her Majesty's Government

PRINTED FOR HER MAJESTY'S STATIONERY OFFICE

AND SOLD BY

LONDON:—LONGMANS & CO.; JOHN MURRAY; MACMILLAN & CO.; SIMPKIN, MARSHALL & CO.
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EDINBURGH:—ADAM & CHARLES BLACK AND DOUGLAS & FOULIS.
DUBLIN:—A. THOM & CO. AND HODGES, FIGGIS, & CO.

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EDITORIAL NOTE.

THE Report on the CALCAREA, by Dr. N. Poléjaeff, was published at the end of last year as Part XXIV. of the Zoological Series of Reports, and the present Report on the KERATOSA is by the same author, and will be welcomed by all Spongiologists.

The Manuscript was received on 16th April 1884.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, 20*th September* 1884.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the KERATOSA collected by H.M.S. Challenger during the years 1873–76. By N. POLÉJAEFF, M.A. of the University of Odessa.

INTRODUCTION.

THE Keratose Sponges do not belong to the deep-sea fauna; it is therefore not surprising that the number of forms brought home by the Challenger Expedition does not exceed the comparatively small number of thirty-seven (twenty-one new, three undeterminable). But if not numerous, the collection is still very interesting, embracing as it does almost all the genera of the horny sponges hitherto distinguished, and most of the specimens being in a very good state of preservation.

Entering upon their classification and description, I feel myself in a position rather different from that which I occupied some months ago when writing about the Challenger Calcarea. For in this latter case I had to deal with but one elaborate system (that of Haeckel), and my task consisted simply in the reconciliation of Haeckel's systematic arrangement with the modern state of spongiological knowledge. In the group of Keratose Sponges the classifier meets with many detailed systems, constructed in many instances upon radically different principles. My first task is consequently to show which of the existing systems is to be most recommended, and with what modifications. There are two ways of doing this. One way might be called "historical," and would consist of a critical discussion in chronological order of all the systems of the horny sponges we possess; the second might be called "morphological," and would consist of a critical discussion of the comparative systematic value of their different organs. I purpose choosing this latter mode, for the following reasons. Firstly, because it ensures the avoidance of superfluous repetitions, the existing arrangements of the Keratosa being con-

flicting in some points and harmonious in others. Secondly, because it promises more logically fitting opportunities, whilst discussing the discoveries of other spongiologists, of communicating whatever observations of general interest I have made whilst examining the Challenger material, so that the descriptive part of this memoir may be for the most part exclusively devoted to systematic purposes. The following pages accordingly consist of a discussion of the organisation of the Keratosa and of the principles of their classification.

I.—ORGANISATION AND CLASSIFICATION OF THE KERATOSA.

One might perhaps feel inclined to say that this title promises but very little; that a classifier has to search for systematic characters not only into the organisation of the animals in question, viz., into their Anatomy and Histology, but also into other regions of Biology, and, in the first instance, into Embryology and Palæontology. Unluckily this is impossible so far as the horny sponges are concerned. Some fossils have been described which may possibly be referred to the Keratosa, but this cannot be regarded as scientifically proved, nor is the number of such forms sufficient to permit any further conclusions.[1] The possibility of a *future* application of Palæontology to phylogenetic purposes respecting the Keratose Sponges is not entirely excluded, though there are reasons to believe that this group is a very recent one, but up to the present time the application above mentioned is impossible. Again, with respect to embryological data even such a modest hope cannot be assumed. Of course our knowledge is still very fragmentary, but what we know only confirms the opinion that the ontogeny of the horny sponges is very monotonous, and that therefore its further profound study would probably be of consequence only for the solution of certain *embryological* problems (in the strict sense of the word), but not of much service in augmenting the number of systematically important characters. The classifier is thus thrown on the resources of Anatomy and Histology alone; chiefly on those of Anatomy, since it is only in exceptional cases, as in *Ianthella* or *Cacospongia vesiculifera*,[2] that histological characters can be applied to systematic purposes. But, nevertheless, this would be of no further consequence were the anatomical characters of, so to speak, unconditional value. Yet even this is not the case, and this is just what renders the classification of the Keratosa so very difficult, and makes the danger of "describing individuals instead of genera and species" (O. Schmidt) greater in this group than elsewhere. For Comparative Anatomy can only state this or that difference in organisation, but is very often quite powerless, at least in the Keratosa, to decide the question whether this or that anatomical peculiarity is constant or merely accidental. It is therefore obvious that the systems of the Keratosa we are now so diligently elaborating will prove, with the progress of the Comparative Physiology, to

[1] Zittel, Zur Stammesgeschichte der Spongien, München, 1878, p. 9.

[2] Page 58 of this Report.

be in many points quite artificial; but we must console ourselves with the impossibility of altering the matter, and although with respect to this group we have to deal with anatomical characters almost exclusively, we must ground upon them our systematic arrangements, proceeding, however, with all possible prudence, and bearing in mind the necessity of a critical attitude towards our own conclusions.

These general remarks will now be followed by more special observations as to the systematic value of various characters of the sponges in question. I begin with the properties of the skeleton. Its high systematic significance has always been recognised; what is more, it has been exaggerated. The systems of Duchassaing de Fonbressin and Michelotti,[1] of Gray,[2] Hyatt,[3] Carter,[4] are founded simply on its properties. In the diagnoses of the last-named naturalist, indeed, the "sarcode" is also very often spoken of; but these particulars might in almost all cases be omitted; and it is precisely owing to the circumstance that the former spongiologists were inclined to pay to the properties of the skeleton an exclusive attention, that its modifications for a long time past have been submitted to a careful study, and considerable differences in its structure discovered. It has been stated that while in some of the Keratose Sponges the horny fibres show no differentiation in their central and peripheral parts, the fibres of the skeleton of many others admit of a distinction into a central pith-substance ("Marksubstanz" of German authors) and of a horny laminar envelope; and while the *homogeneous* fibres are almost always more or less cored with foreign bodies, so that the horny substance shows in many instances a tendency to disappear entirely, the *heterogeneous* skeletal fibres, on the contrary, are in most cases quite free from any foreign enclosures. Finally, it has been stated that in certain sponges (*Ianthella*) the horny envelope of their skeletal fibres is charged with true cells (Flemming,[5] Carter[6]). To the first of these characters the greatest systematic significance has been repeatedly ascribed, and the two spongiologists to whom we owe the most elaborate systems of Keratosa (Carter and Hyatt) have made use of it in order to subdivide the group into two main divisions (Ceratina and Psammonemata, Carter; Aplysinæ and Sponginæ, Hyatt), which proceeding deserves a more detailed critical study, since we have recently learned from the spongiological writings of F. E. Schulze that the above-mentioned differences in the properties of the skeleton present a certain antagonism with regard to the internal structure of the soft parts, that both in Ceratina or Aplysinæ and Psammonemata or Sponginæ two types, or at least modifications, of the canal system, are to be seen. Schulze ascertained, in fact, that while an *Aplysina*, and on the other hand a *Euspongia* or *Cacospongia*, are characterised, in the organisation of their canal system, by comparatively small, round, or pear-shaped

[1] Spongiaires de la mer Caraibe, Harlem 1864. [2] *Proc. Zool. Soc. Lond.*, 1867, pp. 503, 508.
[3] Revision of the North American Poriferæ, *Boston Soc. Nat. Hist.*, 1875 and 1877.
[4] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xvi. pp. 132, 134–140, 1875.
[5] *Würzburger Verhandl.*, N. F., Bd. ii. [6] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. viii. p. 112, 1881.

flagellated chambers, each possessing its own narrow inhalent and exhalent canaliculi, and while the ground-mass surrounding these flagellated chambers is always opaque owing to the presence of small granules, the forms like *Spongelia* and *Aplysilla* possess no special cameral canaliculi, their large pouch-shaped flagellated chambers receiving the water from the subdermal cavities directly by means of the pores in their walls, and expelling it also immediately, without the help of any intermediate narrow canals, into large exhalent cavities, the diameter of these latter being usually far larger than that of the exhalent opening of the corresponding flagellated chambers; and that in these latter instances the parenchyma in the zone of the flagellated chambers is devoid of any granules, being lucid and transparent.

It remains to be decided what position the modern systematist should take with respect to the antagonism in question. F. E. Schulze himself gives in his papers no answer to it. He assigns[1] to *Aplysilla* the place of a new genus in his family Aplysinidæ, while he is inclined to regard the genus *Spongelia*, an analogue of *Aplysilla* in the Keratosa with homogeneous skeletal fibres, as the representative of an independent family.[2] Again, his distinguished pupil Dr. Vosmaer, stands also perfectly neutral, dividing, in his interesting paper on *Velinea gracilis*,[3] all the Keratosa directly into families, according to the properties both of the soft parts and of the skeleton. But though neutral as far as his actions are concerned, Dr. Vosmaer expresses very clearly his opinion on the matter. He does not ascribe any special importance to the difference between the fibres, whether homogeneous or heterogeneous. On the contrary, another pupil of Prof. Schulze, Dr. v. Lendenfeld, seems inclined to accept the opinions of Hyatt and Carter. At least, in his memoir on the Aplysinidæ of the South Sea, he characterises[4] the family of Aplysinidæ by their heterogeneous skeletal fibres, splitting it into two subfamilies, that of Aplysininæ and Aplysillinæ, according to the type of the canal system. And, indeed, such a proceeding appears at first sight very logical and natural. Of course, on the whole, the canal system is of greater significance for the sponge organism than the skeleton. No sponge can be imagined without canal system, be it represented as in Asconidæ by the undifferentiated central cavity without any trace of separate flagellated chambers, or, as in *Aplysina* or *Corticium*, by a very complicated system of subdermal cavities, inhalent cameral canaliculi, flagellated chambers, exhalent canaliculi, &c., while there are sponges, like *Halisarca*, *Oscarella*, or *Chondrosia* without any supporting apparatus. It should not, however, be overlooked that whatever importance may be ascribed to the canal system, this importance is of a pronounced physiological character. On the contrary, so far as the properties of the skeleton are concerned,—all this holds true within the group Keratosa, and the last-mentioned point with regard to its internal

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 404.
[2] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 117.
[3] *Mittheilungen a. d. zool. Station zu Neapel*, 1883, p. 444.
[4] *Zeitschr. f. wiss. Zool.*, Bd. xxxviii. p. 309.

structure,—they appear to be of a more trustworthy morphological character. The function of the skeleton is to support the soft parts. The heterogeneous and homogeneous skeletal fibres are equally fit for this function; and when once a sponge has adopted the heterogeneous fibres, it would but conserve them. One might logically compare the heterogeneous and homogeneous skeletal fibres with calcareous and siliceous skeletal spicules, these latter propping the sponge-sarcode equally well in both cases; and since it is necessary to separate systematically the Calcarea and Silicea, it must be equally necessary to separate the Ceratina and the Psammonemata.

To sum up, the procedure of the above-mentioned systematists may be regarded as very logical. Yet each question admits of numerous answers equally logical and undeniable; and it is not to be forgotten that what we think to-day to be thoroughly logical, we may perhaps regard to-morrow as quite impossible, that the really logical is that which alone corresponds with the reality. The ascribing of such systematic importance to the properties of the skeleton in question cannot be reconciled with the reality, and in no case can these properties serve as the basis for the primary subdivision of the group Keratosa. Such a subdivision would express that the Keratosa with homogeneous skeletal fibres form one phylogenetic branch of the group, the Keratosa with heterogeneous fibres another, phylogenetically equivalent to the first, the intermediate connecting links having died out. This, however, is not the case, the differences in the structure of horny fibres, as already pointed out by Vosmaer, being but of a quantitative nature. There are amongst the Keratosa, forms, the horny envelope of whose heterogeneous skeletal fibres is very thin (*Aplysina*, *Aplysilla*, *Darwinella*), so that the pith-substance forms the main part of the fibre; there are again other forms (*Verongia*, *Luffaria*), the horny walls of whose fibres are far thicker, and, at least in some representatives of the genus *Luffaria*, there are to be found amongst fine fibres, fibres quite similar to those of *Euspongia*, or *Spongelia*, viz., fibres apparently entirely devoid of any central differentiation (Pl. IX. fig. 6). I say apparently, for, thanks to F. E. Schulze, we know that each normal horny fibre does possess what he calls an "Achsenstrang." He has been able to discern it in the fibres of *Euspongia*[1] and *Spongelia*,[2] and that certain homogeneous fibres show no differentiation, even under high microscopic power, seems to be due to the fact that, hand in hand with a more voluminous development of the pith-substance, there is a variation in its chemical and optical properties. In the fibre of an *Aplysina* or *Aplysilla* the core and the surrounding horny laminæ can be readily distinguished under very low magnifying power, and the designation "hollow-fibred," which has been adopted by many spongiologists with respect to forms like *Aplysilla* or *Verongia*, owes its existence to the fact that even when simply dried out, the skeletal fibres of the above forms show no more trace of the pith-substance.

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 633.

[2] *Ibid.*, pl. vi. figs. 6 and 7.

On the other hand, in *Luffaria* the horny laminæ and the central differentiation of its fibres resemble each other optically in a far greater degree; higher powers of the microscope are necessary in order to show this internal differentiation; when dried, the fibres still possess their core, and only after treatment with caustic alkali or ammonia do the fibres become hollow. Certain differences are also to be found in the structure of the pith-substance. While in *Aplysina* or *Verongia* the core is represented by a fine and irregularly twined network,[1] in *Luffaria* the structure of the core of its fibres appears similar to that of its horny envelope, being however represented not by continuous laminæ, but by minute horny splints, still disposed parallel to one another, as well as with regard to the surrounding laminæ, just as Schulze has figured[2] the central canal of the fibres of *Spongelia pallescens*. But though the core of the skeletal fibres of *Luffaria* appears to be structurally quite equivalent to that of *Euspongia*, and differs considerably from that of typical Aplysinidæ, it would still be premature to assume that *Luffaria* is but a specifically modified Spongid, and not a link connecting the Aplysinidæ with the Spongidæ, in consequence of the identical manner in which both kinds of fibres, the heterogeneous as well as homogeneous, develop.

It has indeed been stated—I allude to Dr. v. Lendenfeld's[3] observations—that the development of the heterogeneous fibres only slightly resembles that of the homogeneous ones; that while, according to Schulze,[4] the skeletal fibres of a *Cacospongia* or *Euspongia* grow by reason of the activity of *spongoblasts* exclusively, the growth of a heterogeneous fibre is dependent on the function both of spongoblasts and *spongoklasts*. Like F. E. Schulze, Dr. v. Lendenfeld distinguishes two kinds of spongoblasts—those of elongated, and those of polygonally massive, form; the first are to be found along the developing fibre, the second on its summit. He thinks, however, that the function of the last-named is not to secrete the pith-substance of the central canal, but to sink down into the interior of the developing fibre, in order to transform into pith-substance the original horny mass, secreted by the elongated spongoblasts (Ich nehme an, dass die Zellen in den Kuppeln, gleich den Osteoklasten der Wirbelthiere, die harte Rinde der Skelettheile auflösen und in Marksubstanz verwandeln). This statement Dr. v. Lendenfeld accompanies by an illustration, and recalls on this occasion the statements of Flemming as to the structure of the skeletal fibres of *Ianthella*, which he (Dr. Lendenfeld) supposes to be very nearly allied to his *Dendrilla*, and in whose fibres the presence of true cells has been proved. Of course there can be no doubt that the skeletal fibres of *Ianthella* are charged with true cells. The statements of Flemming have been corroborated by Carter, and, for my own part, I can only confirm their observations Yet these cells have been found not in the pith-substance, but between the surrounding

[1] Comp. F. E. Schulze's statements on this point in *Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 401, and my drawing, Pl. X. fig. 3.
[2] *Zeitschr. f. wiss. Zool.*, vol. xxxii., pl. vi. fig. 6; comp. my drawing, Pl. IX. fig. 6.
[3] *Zeitschr. f. wiss. Zool.*, vol. xxxviii. p. 291.
[4] *Ibid.*, vol. xxxii. p 635.

horny laminæ, and Flemming,[1] like Carter,[2] emphatically denies their occurrence in the core of the fibres. My own endeavours to discern them there have been equally unsuccessful, and this not only with regard to *Ianthella*, but also with regard to *Verongia*, *Aplysina*, *Darwinella*, and *Aplysilla*, in which connection I should lay stress on the fact that the specimens of *Aplysilla sulphurea*, kindly placed at my disposal by Prof. F. E. Schulze, have been examined both in the living state as well as preserved by the methods recommended by Dr. v. Lendenfeld. In no single case have I been able to discern in the central canal of the horny fibres anything that might be regarded as spongoklasts.

Again, Dr. Vosmaer states the same with respect to his *Velinea gracilis*.[3] And far from supposing that Dr. v. Lendenfeld has described what he did not see, I feel convinced that he has misinterpreted what he did see. It may be said that what does not occur in *Ianthella* or *Aplysilla* may be characteristic of *Dendrilla*. Such a possibility indeed is not excluded, but it is extremely improbable. For, firstly, *Dendrilla* seems to be so closely allied to *Aplysilla* that both these genera will probably in time be united into one; and secondly, because with an instrument like the microscope one sees very often precisely what one desires to see, and that Dr. v. Lendenfeld has been desirous to find out his spongoklasts is beyond any doubt, the spongoklasts having been for him a logical necessity. He refers in his above-mentioned memoir to the statements of F. E. Schulze as to the fact that, though on the whole the old larger skeletal fibres of *Aplysina aërophoba* must be called thick-walled, the young ones of small diameter on the contrary thin-walled, still the diameter of the central pith-substance in larger fibres is comparatively greater than that of the small ones. He tells us further that the same can also be said with respect to the Aplysillidæ which he had for examination, and he deduces from this the conclusion that hand in hand with the growth of the fibre its pith-substance increases also.[4] If all this be so, indeed, without the theory of spongoklasts, the phenomenon would be quite inconceivable. I must, however, deny the reliability of the statements in question. The fibres of the representatives of the genera *Ianthella*,[5] *Verongia*, and *Luffaria* have been submitted by me to the most careful examination, and I must state that in all the above specimens I found very often fibres of the same size but with different diameters of the central canal; and since I find also that this is the case not only as regards the fully developed fibres but also those in embryonic condition, I believe that the phenomenon we are speaking of is easily explained without any reference to spongoklasts, if we assume that the pith-substance is a product of the *polygonal* spongoblasts, and the laminar horny substance the product of those of elongated shape, and that the differences in diameter of the central canals are dependent upon their having been deposited broad or narrow. The second

[1] *Loc. cit.*, p. 4.
[2] *Loc. cit.*, p. 115.
[3] *Loc. cit.*, p. 441.
[4] *Loc. cit.*, p. 290–293.
[5] I should call attention to the fibres constituting the skeleton of the stem of this sponge; some of them are far thicker than the primary fibres of its leaf-like part, but, nevertheless, with the diameter of the central canal not only considerably smaller than that of the primary fibres just mentioned, but occasionally not larger than that of a *Spongelia*.

conclusion, as stated before, is founded on actual facts; as to the first, I have no decisive proofs for it, but I believe it will yet be adopted, at least provisionally, as a hypothesis of comparatively great probability. That it is so, when compared with that of Dr. v. Lendenfeld, is evident, since it does not, as does his theory, contradict the actual facts; that, again, the intussusception theory of Prof. Schulze [1] is not plausible has been indicated by Dr. v. Lendenfeld [2] himself.

The foregoing remarks have had two distinct aims: first, to give a plausible explanation of the phenomenon of the formation of the horny fibres; and second, to show that this phenomenon is the same with regard both to the homogeneous and heterogeneous fibres. Whether I have succeeded in my first task will be shown by later investigations; at any rate we must assume that the elements forming the homogeneous horny skeletal fibres are just the same as those secreting the heterogeneous fibres; and since in both cases no special functional transformations of any of these elements take place, we must come to the conclusion that, in thorough harmony with the fact that homogeneous and heterogeneous horny fibres differ from one another only quantitatively, the development of both kinds of fibres admits also of only relative distinction; and that, accordingly, the subdivision of the Keratosa into two groups, the one characterised by homogeneous, the other by heterogeneous, skeletal fibres, would be thoroughly artificial. Whether such a subdivision may be made according to the structure of the canal system will be discussed later on. I proceed for the present to treat of the modifications of the skeleton, and now pass on to those influenced by the tendency of most of the Keratosa to take up foreign bodies into their skeletal fibres.

As is well known, this tendency is characteristic only of Keratosa with homogeneous skeletal fibres. Beginning with forms like most *Coscinodermata* and *Hippospongiæ*, whose fibres contain foreign bodies only exceptionally, here and there a sand-grain or fragment of a spicule, going on to forms like many representatives of the genera *Euspongia* and *Cacospongia*, whose primary fibres are full of foreign enclosures, but the secondary ones in most cases quite free from them, and, further, passing by forms like *Psammoclema vosmaeri* or *Spongelia avara*, both kinds of fibres of which are overcharged with foreign enclosures, we come to the genus *Psammopemma*, characterised by an entire absence of any fibres, the supporting skeleton consisting of sand-grains, portions of Foraminiferal shells, fragments of spicules, &c., all lying separately, the secretion of the horny substance being reduced to the formation of a thin horny envelope around each foreign body.

To this tendency, again, a high systematic importance has been ascribed. Gray [3] and Marshall [4] characterise their family of Dysideidæ mainly by the richness of their fibres in foreign enclosures. The systematic application of this character plays also a great

[1] *Zeitschr. f. wiss. Zool.*, vol. xxx. p. 403.
[2] *Loc. cit.*, p. 291–292.
[3] *Proc. Zool. Soc. Lond.*, 1867, p. 503.
[4] *Zeitschr. f. wiss. Zool.*, vol. xxxv. p. 92.

part in the system of Mr. Hyatt.[1] Again, Mr. Carter makes an exclusive use of it as to the special subdivisions of his order of Psammonemata, following the principle of "beginning with horny fibre sparingly cored with foreign bodies, in order to go to that in which the core is more general, and finally to end with that in which the horny element is scarcely visible, and the core of foreign bodies only held together by a minimum of sarcode, like the spicules in the Holorhaphidota."[2] That, as a matter of fact, *all* the naturalists in question have been wrong in this proceeding is clear to every one who is at all acquainted with the recent progress of spongiology; but as to Mr. Hyatt, I must still add that logically he has had the best grounds for the division of the genus *Dysidea* (*Spongelia*) into two independent families. His dermal-membrane theory of the formation of skeletal fibres is false; the dermal membrane, as we know now, stands in no connection with this formation. Furthermore, it is improbable even theoretically, and indeed more difficult to understand than the phenomenon itself, but having once adopted the idea that in different sponges the secondary fibres are of quite different origin (those of his *Spongelia* owing their formation to his "mesoderm," those of his *Dysidea* to his "ectoderm"), he was certainly right in ascribing to this difference the significance of a family character. For this character would be an *absolute* character, while Carter and Marshall have been sure of the contrary. Of course, the proceeding of Mr. Carter is still comprehensible, since his system was devised before the important investigations of F. E. Schulze were published, but the proceeding of Dr. Marshall is to me quite inconceivable. He makes use of a quantitative distinction in order to characterise a family.[3] I am very well aware that the systematic definitions we give to the species, genera, and accordingly to the families, particularly when young groups of animals are concerned, must be according to circumstances more or less conditional. But this is the privilege of natural arrangements. Is that of Dr. Marshall's Dysideidæ a natural one? Surely not. Among his Dysideidæ we find sponges with quite different internal organisation. We find[4] there *Oligoceras collectrix*, F. E. Schulze, a sponge whose canal system follows the type of that of Spongidæ; we find[5] there some representatives of the genus *Dysidea*, whose canal system presents, according to Marshall, quite different characters—those of a vesicular type; we find[6] there also sponges with a canal system arranged according to the so-called dendroid type, which has no more real existence than the vesicular type; finally, we find[7] there sponges whose canal system could not have been made out, the specimens having been very badly preserved. Dr. Marshall calls F. E. Schulze the most eminent spongiologist of the present time; he calls his spongiological papers brilliant; but the chief merit of F. E. Schulze consists precisely in having made

[1] Revision, &c., part ii. p. 482. [2] *Ann. and Mag. Nat. Hist.*, ser 4, vol. xvi. p. 135, 1875.

[3] "Die Dysideiden sind Hornschwämme bei denen die auch allen übrigen Hornschwämmen in höherem oder geringerem Masse innewohnende Fähigkeit das eigene Skelett durch aufgenommene Fremdkörper zu verstärken, den höchsten Grad erreicht hat."—*Loc. cit.*, p. 92.

[4] *Loc. cit.*, p. 92. [5] *Loc. cit.*, p. 99. [6] *Loc. cit.*, p. 105. [7] *Loc. cit.*, p. 98.

out the internal organisation of the Porifera and applied it to systematic purposes. Prof. Schulze[1] characterises his family of Spongelidæ primarily by the structure of the soft parts; in Dr. Marshall's diagnosis of Dysideidæ not a single word is devoted to this character. Does he regard it as devoid of any systematic importance? This seems to be the case, but the grounds for this opinion are not to be found in Dr. Marshall's paper, and without this the paper in question is of very doubtful profit for systematic knowledge, and this is the case with *every paper on the Keratosa based on specimens insufficiently preserved for anatomical examination.* Such papers, if from the pen of authors of talent, may still contain something of general interest, and this is in a high degree the case with regard to Dr. Marshall's memoir on Dysideidæ and Phoriospongiæ, but just on that account it is the more to be regretted that from a systematic point of view this memoir only renders the systematic chaos relating to the group Keratosa still more impenetrable.

In the Bemerkungen über die neue Gray'sche Hornschwammgattung Ianthella[2] by Dr. Flemming, spongiological literature has been enriched with a new and very valuable contribution to our knowledge of the properties of the horny skeleton. Dr. Flemming has stated—and, as I before remarked, I can but confirm his statements—that the fibres of *Ianthella flabelliformis* and *Ianthella basta* contain true cells between the laminæ of their walls. The specimens of both (?) the species obtained and examined by Dr. Flemming were dried, and thus he has not been able to decide the question as to whether *Ianthella* is really to be referred to *Porifera.* He believes, however, that, if so, a very isolated place in the group is to be assigned to this sponge ("Es scheint mir zunächst nicht viel übrig zu bleiben, als sie bei den Spongien, aber auf einem sehr isolirten Platze einstweilen stehen zu lassen").[3] Dr. Flemming's suggestion is to be regarded as quite natural, if we remember that his paper on *Ianthella* appeared in the year 1871, *i.e.*, five years before the important discovery of spongoblasts by F. E. Schulze; but at present one may perhaps form another opinion as to the systematic importance of the peculiarity in question. The gist of the matter consists in the fact that each horny fibre is the product of cellular elements; and whether the spongoblasts, after having accomplished one part of the work, recede before the developing fibre in order to partake in its further growth, or remain in their former places in order to be buried in the horny substance secreted by younger spongoblasts, seems to me to be of secondary significance. Dr. Flemming demands for *Ianthella* a quite isolated place amongst the Keratosa; again, Gray, Carter, and Hyatt, on the ground of characters of undoubtedly less value, of characters to which in other instances we should apply only a generic if not a specific significance, are inclined to regard it as the representative of an independent family. For my own part, I must confess frankly that the systematic importance of the peculiarity we are speaking of is rather ambiguous. For though, as before

[1] *Zeitschr. f. wiss. Zool.*, vol. xxxii. p. 153.
[2] *Würzburg Verhandl.*, N. F., Bd. ii.
[3] *Loc. cit.*, p. 7; comp. also p. 6.

stated, from a theoretical point of view it appears to be but of a subordinate character, the possibility is not excluded that the property in question might have been assumed very early (in a palæontological sense), and thus if we should in time find Ianthellidæ, *i.e.*, horny sponges whose skeletal fibres are charged with true cells, of thoroughly different internal organisation, we should be obliged to elevate the character in question to the rank of that of a subfamily or even family. But hitherto this has not been the case; all the Ianthellidæ known up to this time are only representatives of the same genus, and in order to avoid a superfluous overburdening of spongiological nomenclature, sufficiently overburdened already, I should propose to regard temporarily the genus *Ianthella* as merely a genus of the family Darwinellidæ (Aplysillidæ), the more so as to a similar variation (in the reverse direction, however,) in the Vertebrata[1] no systematic consequence has been ascribed.

This would be the place to discuss the systematic value of the organisms known by the name of "Fibrillen" or "filaments," which for a long time have been considered a constituent part of the horny skeleton. The inducement to this has been given by the statements of Oscar Schmidt, who thought[2] he had seen filaments in immediate connection with true horny fibres. On the ground of this false supposition he adopted the genus *Hircinia*, Nardo, and characterising it primarily by the presence of filaments, subdivided it into two subgenera; Gray[3] in the year 1867, relying on Oscar Schmidt's statements, established a new family "Hircinidæ," characterised by the possession of a, so to speak, double skeleton. There has been however, on the part of other spongiologists, some doubt as to the reliability of Schmidt's statements. Kölliker[4] proclaimed the filaments to be parasites, and this opinion has been warmly defended also by Mr. Carter,[5] apart from the point that, according to Kölliker, the filaments are fungi, according to Carter, algæ. In the meantime, Prof. Schmidt[6] altered his opinion; further and more careful examination led him to the conclusion that the filaments were in no connection with the true skeleton, and this suggestion has been confirmed also by Schulze in his paper on "die Gattung *Hircinia*, Nardo und *Oligoceras*, g. n." Agreeing so far as the real facts are concerned, both the investigators just named differ, however, with regard to further conclusions. In his report on the Spongien der Küste von Algier Prof. Schmidt believes[7] that if it were once proved that the filaments are nothing but parasites, the genus *Hircinia* ought to be dissolved as an independent genus, and incorporated in the genus *Cacospongia*. Prof. Schulze comes to quite a different conclusion; while inclined, as he has been, to regard the filaments as independent organisms, he ascribes[8] to their presence in certain Keratosa a generic and even family character, which

[1] I allude to the osteoblastless skin-bones of Cœciliæ (Leydig) as well as to the equally osteoblastless bones of Teleostei supporting their fins (Kölliker).

[2] Spong. d. Adriat. Meeres, pl. iii. fig. 10.

[3] *Proc. Zool. Soc. Lond.*, 1867, p. 503.

[4] Icones histologicæ, Abth. i. p. 49.

[5] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. viii. p. 330, 1871.

[6] *Zeitschr. f. wiss. Zool.*, Bd. xxxi. p. 661.

[7] *Loc. cit.*, p. 36.

[8] *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. p. 34.

opinion, in spite of objections made by Dr. Marshall,[1] has also been adopted by Dr. Vosmaer.[2] Prof. F. E. Schulze is indeed the most eminent spongiologist of the present time; Dr. Vosmaer is his pupil, and since I have entirely different ideas on the matter, I must submit it to a most careful examination. There are three questions to be answered, namely, first, whether the filaments form a constituent part of the organism of certain sponges or are independent organisms? second, if they are independent organisms are they to be regarded as parasites? and third, if so, is their presence to be used as a character of systematic consequence?

Do the filaments stand in an intimate connection with the sponge organism, or are they independent beings? We have seen that this question has been answered in the negative by numerous investigators. This negative answer has, however, had either no foundation in fact, or only an ambiguous one, till F. E. Schulze's paper on *Hircinia* appeared. What we read in the Icones histologicæ of Kölliker (p. 49) is to be regarded merely as a simple supposition; in the papers of Carter and Hyatt we have indeed to deal with a conviction, but this conviction is far from being contagious. Hyatt states[3] nothing more than that the examination of filaments by Dr. Farlow led to no definite results as to their nature. Carter wishes to prove their parasitic nature by the fact that he did find filaments in many non-Keratosa, and again missed them in notorious Hircinidæ such as *Hircinia campana*. It may be said, however, that, as to the latter argument, the sponges in question have accordingly not been Hircinidæ, and as to the former one, that it is also of no decisive nature, the reliability of the observations upon the point being still questionable. This has been pointed out by F. E. Schulze in his above-mentioned paper (p. 33), and there has been no answer on the part of Mr. Carter. The discovery of O. Schmidt that the filaments, which by their shape vividly recall skipping-ropes, are quite free at both extremities, proved that they had nothing to do with the skeleton, but did not prove their independence of the sponge organism in general. This latter has been made obvious by Schulze, who made out the structure of sponges characterised by the presence of filaments, and found that anatomically and histologically they do not differ from sponges which like *Euspongia* have never been found with filaments. To this statement I ascribe the highest importance. If the filaments have nothing to do with the skeleton, and if again there exist no deviations in histological structure of the corresponding sponges, which deviations, according to the law of correlation, ought to be expected, provided that filaments form a constituent part of their body, there are no grounds to consider them to be part of it. Whether they are algæ or fungi still remains questionable, but their nature as independent organisms is, I think, now clearly established. Schulze himself is also of this opinion, although, with his usual prudence, he states it rather conditionally. Notwithstanding, he is still inclined to ascribe to the presence of filaments a high systematic significance; he appeals to an analogous instance in the vegetable kingdom. He

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxv. p. 112. [2] On *Velinea gracilis*, p. 445. [3] Revision, &c., part ii. p. 546.

says the lichens are also nothing but fungi and algæ together; still, they form a systematically independent subdivision, owing precisely to their double nature. I do not know whether botanists are right in separating systematically the lichens, but this question is of no consequence to us; I do not, however, believe the comparison just mentioned to be fortunate. The lichens represent an extreme instance of that kind of symbiosis which v. Beneden calls "mutualismus." The symbiosis of filaments with sponges is even not so much a commensalism as an indubitable parasitism. In the case of mutualism, the beings constituting the whole undergo such modifications in their structure that a separate existence becomes impossible. There are to be found no deviations in the organisation of sponges attacked by filaments, as compared with that of closely allied forms devoid of them. Microscopic preparations of *Hircinia variabilis* and *Cacospongia scalaris* show no differences apart from the presence and absence of filaments. There are, accordingly, absolutely no grounds for supposing that *Hircinia*, having got rid in some manner or other of filaments, would be no longer able to live. It is also quite obvious that the phenomenon under consideration is not commensalism, but parasitism. Beginning with forms like the Challenger specimen of *Cacospongia collectrix*, where filaments are represented but very scantily, we come through all possible intermediate stages to the forms which, as in the case of the Challenger specimen of *Cacospongia irregularis*, are so overloaded with them that the parenchyma is almost entirely replaced by these curious organisms; all this, now that the independence of the filaments is no longer doubtful, seems to me a decisive proof in favour of the opinion held for many years by Carter, that in the filaments we have really to do with nothing but parasites. This conclusion alters the matter. There are instances in which the diagnosis of parasites involves the mention of the host they inhabit. This does not occur, however, except in connection with certain modifications in the structure of the parasite, rendering it impossible for it to inhabit another host; but nobody would characterise the host systematically by reference to its parasites, and should we adopt the family of Hircinidæ as a family represented by forms with filaments in the parenchyma, we should be equally obliged to subdivide the species *Homo sapiens*, according to the presence or absence of *Tænia solium*, into two systematic groups. Hence I propose the dissolution of the family Hircinidæ, and the location of its representatives in other groups, according to more positive characters.

The question as to the nature of the filaments, whether plants or animals, is therefore beyond the domain of spongiology; but since it is of great general interest, I venture to communicate here what I was able to make out in this direction during the examination of the Challenger material. As to their structure, I must refer the reader to the statements of F. E. Schulze. I was able to discern all he has seen, but was unable —in spite of the excellent homogeneous immersion system ($\frac{1}{24}$) of R. Winkel—to make out anything more as to their organisation. The comparative size and shape of the heads

are shown in Pl. VIII. figs. 4 and 5. What I have to communicate concerns their origin, provided I am right in identifying the dumb-bell shaped bodies whose description will be given later on along with the filaments. Bowerbank, Schmidt, and Kölliker found in many of the specimens characterised by the presence of filaments certain round bodies, and it has been supposed by the last named naturalist that these bodies give rise to the filaments. F. E. Schulze, on the contrary, maintains that there can be no question as to any such connection; he finds these bodies too, but is inclined to consider them to be unicellular algæ, the more so as he has observed them in phases of division more or less complete. I am uncertain whether the bodies I am about to describe, which are represented on Pl. VIII. fig 2, are identical with those of F. E. Schulze and Kölliker. I believe them, however, to be so, since the corresponding description of Schulze is thoroughly applicable to them, and also because I found some of them on the point of dividing into two halves; but even if identical, I am yet more inclined to adopt the opinion of Kölliker, and to ascribe to them a certain connection with the filaments. I observed these round bodies in my *Cacospongia dendroides*, and comparing them with the heads of its filaments, was struck by their mutual resemblance. Not in every case, however; for, beginning with forms characterised by the thickness of their walls and indistinct central differentiation through numerous intermediate stages, I came to forms with walls far thinner, and, in their central contents, recalling very much the drawings Schulze gives of his conjectural algæ in *Hircinia* (*loc. cit.*, pl. iv. fig. 15). An attentive examination of their walls shows that they are provided with a small thickening, which appears to correspond exactly with the spot where the thread of the filament separates from its head. In a couple of cases, I think, I have also seen these bodies, when grown thin-walled, still in connection with the thread; but even if this were not an optical illusion, it seems to occur pretty seldom, and we have also to suppose that the further differentiation of the filamental heads—provided that they are identical with our round bodies—takes place only after the head has separated from the thread. The final phase of this development consists in the bursting of the wall so that the internal contents escape. It is represented by corpuscles which, when out of the capsule, present a great variety of size, some so small that they appear to be merely points, others so large that they are readily to be discerned by a magnifying power no higher than 200–250. In some cases these corpuscles appear to have linear or even fusiform outlines. This, however, is very rare; they almost always have a very definite dumb-bell shape, so that if such a body were to be imagined as growing in length a typical filament would result. But if this really occur, it apparently does not take place immediately, the corpuscles having the faculty of multiplying previously by division; sometimes, but not often, a cross division has been observed, sometimes a star-like one, sometimes a longitudinal one. As the result of this division, a new generation of corpuscles of the same form may again occur. As to their internal structure, I can state that, as in the filamental heads, their walls consist of concentric layers; a

certain differentiation in their centre is also to be discerned, but I am not sure whether this is not the result of an imperfect penetration of the staining fluid into their bodies. Their whole appearance is a "bacterian" one. So much I can state from actual observation. Induced by these observations, I was desirous of pursuing their conjectural transmutation into true filaments. I was, however, unable to accomplish this, and thus corroborate with decisive proof the statement as to the mutual connection of the round algæ-like bodies, the dumb-bell shaped corpuscles and the filaments. Can this be supposed nevertheless? When deliberating over the phenomenon theoretically, I was inclined to answer this question in the negative; for, as remarked before, the dumb-bell shaped corpuscles, having reached a certain size, show in most cases a tendency to multiply, which again cannot be denied with respect to the round bodies themselves. All this would be very strange, if we should identify the former with filamental heads and the latter with filaments themselves; and again, though I have seen single dumb-bell shaped corpuscles of comparatively very large size (0·06 mm.), I never saw them so large that one might regard them really as young filaments; while if they really undergo transformation into filaments, one would expect to find all possible intermediate stages. On the other hand, when examining the corresponding preparations, and comparing the round bodies with the filamental heads and the corpuscles with true filaments, I can give to the above question but one answer—a decided "Yes." But whatever be the fact, I consider it my duty to communicate in a most detailed manner what I have observed, and what may stand in connection with the origin of the filaments, hoping that my statements may be of help to any naturalists who may at some future time enter upon a special research into the nature of these enigmatical formations.

I turn now to a detailed discussion of the systematic value of the properties of the canal system. The diagnoses of the two types of canal system characteristic of Keratosa have been already given on pages 4, 5. It has been also stated that the properties of the canal system are in a certain sense antagonistic to those of the skeleton with regard to its composition either of homogeneous or heterogeneous fibres; and again, that according to this latter character the horny sponges do not admit of their subdivision into two main groups, since such a proceeding would have a certain phylogenetic signification inconsistent with the circumstance that the differences in the histological structure of the skeletal fibres of an *Aplysina* and *Euspongia*, and on the other hand of an *Aplysilla* and a *Spongelia*, are of a quantitative and not a qualitative nature. But, owing to the fact that *Aplysina*, through *Verongia* and *Luffaria*, is connected with true Spongidæ, and again that the genus *Aplysilla* is connected, as Vosmaer has lately shown, through *Velinea* with *Spongelia*, the canal system of the sponges first mentioned being constructed upon one type, that of *Aplysilla*, *Velinea*, and *Spongelia*, including other allied genera upon another, one would question whether the Keratosa can be subdivided precisely according to the structure of their canal system. This question is again to be answered in the

negative, and on grounds of exactly the same nature as those forbidding the subdivision of the Keratosa into Ceratina and Psammonemata, Carter, or Aplysinæ and Sponginæ, Hyatt. There is a striking difference between the canal system of *Aplysilla* and *Aplysina*. The flagellated chambers of the representatives of the genera *Aplysina* and *Verongia* (Pl. X. fig. 7) are small, pear-shaped, or rather hemispherical, each provided with one (?)[1] inhalent and one exhalent narrow canaliculus; and again, the surrounding ground-mass is so very rich in granules that the outlines of the cellular elements in the neighbourhood of the flagellated chambers are scarcely distinguishable. On the other hand, the flagellated chambers of an *Aplysilla* or *Ianthella* (Pl. II. figs. 4 and 5) are large and either of regularly elongated form (pouch-shaped) or of quite irregular outline; no special cameral canaliculi are to be discerned; the flagellated chambers receive the water from the subdermal cavities by means of numerous pores in their walls, and expel it by means of a large exhalent aperture; the surrounding ground-mass is clear and transparent. There are, however, amongst the horny sponges forms uniting these two extreme differences in every direction. As to the size of the flagellated chambers, in *Aplysina* or *Verongia* it is 0·02 mm. on an average, in *Euspongia* or *Cacospongia* 0·026 mm., in *Phyllospongia* 0·037 mm., in *Carteriospongia* 0·05 mm., in *Spongelia* 0·08 mm.; finally, in *Aplysilla* or *Ianthella* the flagellated chambers are still larger, reaching occasionally 0·15 mm. in length by 0·05 mm. and more in width; and it must be noticed—and this is very important—that in some Spongelidæ (comp. Pl. III. fig. 6) the flagellated chambers are again very small, their dimensions not exceeding those of the flagellated chambers of a typical *Euspongia*. Further, as to their form, we have a thoroughly similar series of connecting links. In the Aplysinidæ they are either pear-shaped or rather hemispherical, in the Spongidæ typically hemispherical, in the Spongellidæ more or less roundish, in the Darwinellidæ elongated. The same is also the case with respect to the presence or absence of special cameral canaliculi. While in Aplysinidæ each flagellated chamber possesses but one exhalent, and probably also but one inhalent, canaliculus, these canaliculi being comparatively long and narrow, in the Spongidæ they are short and broad, the inhalent system of each flagellated chamber being besides represented not by one but by three, four, or five canals, which sometimes are so very short that in many cases they can scarcely be properly regarded as special differentiations of the corresponding subdermal cavities. I refer the reader in this connection to the drawing of F. E. Schulze[2] and to my own drawing on Pl. V. fig. 3, and wish to add that in many, indeed exceptional but still numerous, instances I found in true Spongidæ the flagellated chambers devoid of any special *exhalent* canals, but just as is the case with the genus *Carteriospongia*

[1] This question F. E. Schulze (*Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 398) leaves undecided. I also was unable to come to a decisive result with respect to *Aplysina* and *Verongia* owing to the inconvenience of these forms for certain manipulations, but so far in this respect as analogous forms like *Corticium*, *Chondrosia*, and *Chondrilla* are concerned, there can be no doubt that each flagellated chamber possesses but one inhalent canaliculus.

[2] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. pl. xxxvi. figs. 11, 12.

(Pl. V. fig. 8), communicating with the subjacent exhalent cavities by means of a large exhalent opening. Finally, as to the question whether the ground-mass surrounding the flagellated chambers is full of granules or devoid of them; the more or less clear manifestation of this character appears to be in such a high degree dependent on other properties of the canal system that it may be said beforehand that we shall have in this respect a series of intermediate stages between *Spongelia* and *Aplysina* similar to that noticed with regard to the form and size of the flagellated chambers. As is well known, it has been stated by F. E. Schulze that (except in *Oscarella* (*Halisarca*) *lobularis*, which is, however, not a typical representative of the sponges with the canal system after Dr. Vosmaer's[1] 4th type) the ground-mass around the flagellated chambers has been found to be granular whenever the canal system shows a high degree of development in the direction of enlarging the surface washed by the water. But Schulze has also stated that, whenever the development of the canal system has reached its highest point (*Aplysina*, *Chondrosia*, *Corticium*), the ground-mass is literally over-loaded with granules; that further, whenever the canal system possesses a transition character (Spongidæ and particularly Plakinidæ), the granules are by no means so numerous; and, finally, that in the representatives of the genera *Spongelia* and *Aplysilla* the granules are not to be found at all. For my own part, I have been fortunate enough to investigate some forms which are, in this respect, a connecting link between the genera *Euspongia* and *Spongelia*. In *Phyllospongia*—whose flagellated chambers are, as before stated, approximately one and a half times as large as those of *Euspongia* or *Cacospongia*—I could observe the presence of the granules in question only with the help of the system No. 7 of R. Winkel;[2] in *Carteriospongia*—and in this form the flagellated chambers, although of the same shape as those of *Euspongia*, are comparatively much larger and at least in *most* cases devoid of special inhalent and exhalent canaliculi—the granules proved to be extremely few in number, and their presence could have been placed beyond doubt only by the system No. 10 of Winkel.[2] To sum up, we have, with regard to the structure of the canal system, a series of transitions quite analogous to those concerning the skeletal fibres, whether homogeneous or heterogeneous. Accordingly, the final conclusions must be also analogous one to another.

I may now summarise the foregoing observations. There have been discussed five systematic characters, and we came to the conclusion that two of them are absolute characters, the remaining three being only relative. We came also to the result that one of the first-mentioned, namely, the presence of filaments, is capable of no systematic application, and again, that so far as the second absolute character—I mean the presence of true cells in the walls of the skeletal fibres—is concerned, its systematic value cannot, in the present state of our knowledge, be defined.

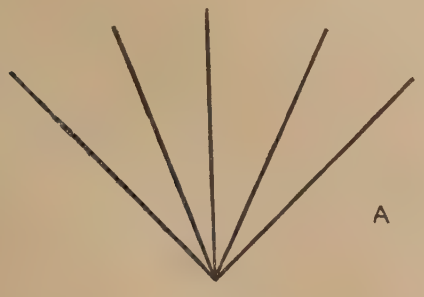
Of the three relative characters, one, the tendency to take in foreign bodies, only

[1] Ueber Leucandra aspera, *Tijdschr. d. Ned. Dierk. Vereen.*, Bd. v. p. 163.

[2] The objective No. 7 magnifies 275–700 diameters, No. 10, 500–1000 diameters, according to the eye-piece employed.

concerns the sponges with homogeneous skeletal fibres, and it has been stated that this character is of a very conditional nature, since the tendency in question is common to sponges of entirely different internal organisation. The properties of this latter, as well as those of the more detailed structure of the skeletal fibres, constitute the two other relative characters, and we have seen that, apart from the point that they are relative, they are also antagonistic to one another in a certain sense of the word. Such is the case with respect to the two characters to which, in the Keratosa, the highest systematic value has been repeatedly ascribed. The fact of their being relative does not permit us to make use of them in order to divide the group in question into two subdivisions, while this is demanded by their mutual antagonism. And yet these characters are undoubtedly the most important, the only characters according to which any main subdivisions may be realised, for they concern the structure of both the constituent parts of the organism of a horny sponge, and as to other systematic characters of the Keratosa, we shall soon see that they are unfit even for good generic distinctions.

What kind of arrangement can be adopted under such conditions? Dr. Vosmaer, as if in order to reconcile the contradictions in question, proposes[1] a subdivision of the group directly into families, characterising them by the properties both of the skeleton and of the soft parts. His arrangement will be adopted in the descriptive part of this paper, as no better arrangement seems at present possible; it is, however, an artificial one. By our systems we have to express the phylogenetic affinities of the corresponding animals, and the arrangement of Dr. Vosmaer does not express them. He subdivides the Keratosa into five families directly. How is this to be understood from a phylogenetic point of view? Are these five families divergent branches from the same spot of the general genealogical tree as represented by the diagram A? or do they form together the figure represented by the



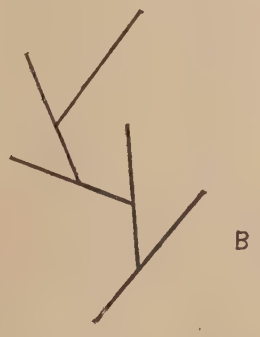


diagram B? There are no answers to these questions, and this is not the fault of Dr. Vosmaer, whose arrangement is at any rate the best of all others, for it pays attention to the characters both of the soft parts and of the skeleton; the matter itself is of a very

[1] On *Velinea gracilis*, p. 444.

ambiguous nature, since systematically the horny sponges present a kind of *circulus vitiosus*. Through *Luffaria* and *Verongia*, *Euspongia* is connected with *Aplysina*, but, on the other hand, it is also, through *Carteriospongia*, connected with *Spongelia*; now *Spongelia* through *Velinea* is connected with *Aplysilla*, and again *Aplysilla* through *Ianthella* is connected with *Aplysina*. It is evident that under such circumstances the families of Dr. Vosmaer are by no means natural systematic groups. With regard to the mutual relations of the genera of different families, such a *circulus vitiosus* is inconceivable, and proves only that such families are not natural. As I remarked before, I adopt the arrangement proposed by Dr. Vosmaer; to attempt a better one would, I believe, be at present premature; but I adopt it only as an arrangement of a provisional character.

The foregoing observations were begun in order to decide the question—Which of the existing systems of the Keratosa is the most to be recommended? The unexpected result at which we arrived is of such high importance that its further foundation becomes desirable, and as this latter demands a detailed discussion of characters used by classifiers as systematic distinctions between different representatives of our conjectural families, I now pass on to those of generic value.

II.—CRITICISM OF THE GENERA.

There are in Science two directly opposite opinions as to the question of what a genus ought to be. Some naturalists demand for the genus the presence of an absolute, qualitative distinction; others are satisfied with a distinction of a quantitative nature, and while, *e.g.*, Nägeli summarises his opinions as follows:—

"Für die generische Trennung scheinen mir folgende Bedingungen als unerlässlich bezeichnet werden zu müssen:

1. Uebereinstimmung im ganzen Verhalten, also innigere natürliche Verwandtschaft unter den Arten der einen und unter den Arten der anderen Gruppe,—und Differenz im ganzen Verhalten, also geringere natürliche Verwandtschaft zwischen den beiden Gruppen.

2. Mangel von Zwischenformen zwischen den beiden Gruppen;—die Arten der gleichen Gruppe können durch Uebergangsglieder verbunden sein oder nicht.

3. Vorhandensein von absoluten (nicht bloss von relativen) Unterscheidungsmerkmalen."[1]

In F. E. Schulze's paper on the Spongidæ[2] we find the following sentence:—"Besonders schwierig erscheint oft die Entscheidung der Frage, ob eine Anzahl verwandter Formen als Arten einer Gattung oder als Varietäten einer Art hinzustellen sind." Under such circumstances it is but obvious that the systematic literature of Keratosa, like that of all other groups, must be of a rather chaotic character. It is so. In the following passages I hope to clear up this chaos so far as the genera are concerned, and so far as this is necessary for the descriptive and some other more general purposes of this paper.

Family Darwinellidæ.

It contains the following genera:—

Darwinella.

This genus was established by Fritz Müller[3] and characterised by him primarily by its horny spicules. There are no data in the literature of the subject as to the internal structure of the soft parts of the representatives of this genus; both F. E. Schulze

[1] *Sitzungsb. d. k. baier. Akad. d. Wiss.*, 1867, Bd. i. p. 168.
[2] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 612.
[3] *Archiv f. mikrosk. Anat.*, 1865, Bd. i. p. 344.

and Vosmaer, though inclined to place it systematically near *Aplysilla*, do so with great reserve, "provided that its internal organisation does not differ from that of other Aplysillidæ." I am in a position to authorise this proceeding entirely. Some time after having published his paper on this form, Prof. Schulze visited a Dalmatian Island, Lesina, and there dredged up specimens of a sponge which does not admit of even a specific distinction from *Darwinella aurea*, Fritz Müller. Prof. Schulze has been kind enough to hand me over these specimens for examination, and I can state that the internal organisation of *Darwinella aurea* follows on the whole the type, anatomical as well as histological, characteristic of *Aplysilla*. Accordingly, and in opposition to Dr. Vosmaer,[1] since the family name of Darwinellidæ was established by Merejkowsky[2] in the year 1878, that of Aplysillinæ, v. Lendenfeld[3] and Aplysillidæ, Vosmaer,[4] only in the year, 1883, I propose to return to the former name of the family in question. The genus *Darwinella* is a good one, its horny spicules differentiating it sharply from all other Keratosa.

Aplysilla, F. E. Schulze[5] (*Simplicella*, Merejkowsky[6]).

Lendenfeld[7] characterises this genus by its crust-like form and by numerous independent tree-like skeletal fibres,—a character common also to *Darwinella*. The distinction consists in the absence of spicules. This genus would be a good one only if united with the next under consideration.

Dendrilla.

Here v. Lendenfeld[8] finds the generic character in the property that the skeletal fibres do not stand separately as in *Aplysilla*, the whole skeleton presenting a single tree with numerous secondary, tertiary, and other branches. This distinction is, however, scarcely of generic consequence. In the Spongelidæ F. E. Schulze[9] has described a form (*Spongelia spinifera*), which differs from other representatives of the genus in the same direction, but even more than *Dendrilla* from *Aplysilla*; yet he merely placed it as a new species in his genus *Spongelia*. At any rate *Aplysilla* and *Dendrilla* show much closer affinities with one another than with *Darwinella* or *Ianthella*.

Ianthella.

This genus was established in the year 1869 by Gray,[10] as the representative of an independent family of horny sponges, and excited among naturalists a great doubt

[1] On *Velinea gracilis*, p. 444. [2] *Mém. de l'Acad. d. Sci. de St. Pétersb.*, tome xxvi., No. 7, p. 44.
[3] *Zeitschr. f. wiss. Zool.*, Bd. xxxviii. p. 235. [4] *Loc. cit.*, p. 443.
[5] *Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 404. [6] *Loc. cit.*, p. 43. [7] *Loc. cit.*, p. 309.
[8] *Ibid.*, p. 270. [9] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 152. [10] *Proc. Zool. Soc. Lond.*, 1869, p. 49.

as to whether it is really a sponge. Flemming[1] and F. E. Schulze[2] have expressed such doubts; and Marshall[3] feels more inclined to regard it as an alga than a sponge. Amongst the Challenger specimens I find two forms which are well-marked representatives of the species *Ianthella flabelliformis*, and which are also distinct sponges with the canal system after the type of that of *Aplysilla* or *Darwinella*. The genus *Ianthella*, like *Darwinella*, is indeed a very good one, its chief generic character, viz., the presence of true cells between the horny laminæ of the skeletal fibres, being of an absolute nature, but it must be added that with respect to the conjectural family Darwinellidæ, this genus narrows the diagnosis of the family as given by Vosmaer (On *Velinea gracilis*, p. 477), the skeleton of its representatives being represented by fibres anastomosing with one another.

Family Spongelidæ.

In the family Spongelidæ (I retain this name since the only one having the priority over it is derived from the still doubtful genus *Dysidea*) six genera have been hitherto distinguished, namely:—

Velinea.

We owe this curious genus to Dr. Vosmaer,[4] who places it in his family of Spongelidæ, notwithstanding that its skeletal fibres are, at least in many instances, obviously heterogeneous, but in accordance with its skeleton being represented by a network of anastomosing fibres; his Aplysillidæ, on the other hand, being characterised by a skeleton of tree-like shape. We have, however, learned that this latter character is not admissible. The skeleton of *Ianthella* is composed of anastomosing fibres, yet these latter are heterogeneous, and the whole internal organisation constructed upon the type of true Darwinellidæ. The fact is that *Velinea* is a connecting link between this latter family and Spongelidæ, and as such it is indeed a very interesting form, but, as an independent genus, belongs to those which from a systematic point of view are very ambiguous.

Spongelia, Dysidea, Psammascus.

In the year 1834 Nardo[5] subdivided his previous genus *Aplysina* into two subgenera, "*Aplysinæ velariæ*" and "*Aplysinæ spongeliæ.*" In the year 1842 Johnston[6] created the genus *Dysidea* for his *Dysidea fragilis*, which, according both to O. Schmidt[7] and

[1] *Loc. cit.*, p. 6. [2] *Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 381. [3] *Jahresb. d. zool. Stat. Neapel*, 1881, p. 161.
[4] *Mittheil. zool. Stat. Neapel*, Bd. iv. Heft. 4, p. 437. [5] *Isis.*, 1834, p. 714.
[6] British Sponges, &c., p. 185. [7] Spong.-Fauna des atlantisch. Gebietes, p. 27.

Marshall,[1] cannot be separated even specifically from *Spongelia pallescens*, Nardo. Notwithstanding, in England, the name *Dysidea* has not been given up, and in order to reconcile English and Continental naturalists, Marshall proposed to retain both these names in order to apply them to different forms. He groups Johnston's *Dysidea fragilis* in the genus *Spongelia* as restricted by F. E. Schulze, and, on the other hand, Bowerbank's species *Spongelia coriacea* and Hyatt's *Spongelia fragilis* in the genus *Dysidea*, giving it a new and detailed diagnosis, and in harmony with Hyatt—who four years before also retained both these genera, and even grouped them in different families on the ground of a thoroughly false supposition as to the manner of growth of the horny skeletal fibres—and, I repeat, in harmony with Hyatt, demands a more pronounced separation of both these genera. This latter view is expressed in a report on his own memoir on Dysideidæ and Phoriospongiæ,[2] while in the memoir itself (*loc. cit.*, p. 91) he seems to be of a rather different opinion, writing as follows: "Ganz scharf zu trennen sind diese genera freilich nicht, so wenig wie *Euspongia* und *Cacospongia*, diese und *Spongelia*." This is, however, of little consequence indeed, but unfortunately, on the whole, instead of having simplified the matter Dr. Marshall complicated it still more. The series of his Dysideidæ in the paper above mentioned he opens by the newly created genus *Psammascus*, characterising it by a great number of peculiarities, each of which, however, must be regarded as almost devoid of any systematic importance. This is also but of little consequence; it is not for the first time that in the Keratosa bad genera have been established and bad generic definitions given, but Dr. Marshall adds to the above definition the following remark: "Of all Dysideidæ this genus (*Psammascus*) shows the closest affinities to the genus *Spongelia*, being however to be readily distinguished from it by the presence of foreign enclosures also in the soft parts."[3] If now the reader will compare the definition Dr. Marshall gives of his genus *Psammascus* (*loc. cit.*, p. 92) with that by which he describes the genus *Dysidea* (*loc. cit.*, p. 98), he will find that this latter genus—apart from the character consisting in the presence of a skin containing numerous foreign enclosures and to be easily drawn off (a character of a very doubtful systematic consequence,[4] but for which nevertheless Dr. Marshall evinces the greatest predilection)—differs from *Psammascus* only in the presence of foreign bodies in the parenchyma; and, when I add, in harmony with F. E. Schulze,[5] that Dr. Marshall has been quite wrong in supposing the true representatives of the genus *Spongelia*, in the sense of F. E. Schulze, to be devoid of any foreign enclosures both in the parenchyma and in the dermal membrane; when I further mention that neither in Dr. Marshall's paper on Dysideidæ nor in the highly detailed and precise memoir on the genus *Spongelia* by F. E. Schulze are any statements to be

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxv. p. 91.
[2] *Jahresb. d. zool. Stat. Neapel*, 1880, p. 178.
[3] *Zeitschr. f. wiss. Zool.*, Bd. xxxv. p. 92.
[4] Comp. F. E. Schulze's discussion of the question in *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. p. 14.
[5] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 136.

found as to the question of whether the upper skin of the representatives of this latter genus is to be drawn off easily or not, and that this is due both to the state of preservation and to the number of foreign bodies in the dermal membrane; and when I finally lay stress upon the fact that Dr. Marshall makes no positive statements as to the internal structure of his genera *Psammascus* and *Dysidea*, so that these forms, like the species *Dysidea coriacea* of Bowerbank and *Dysidea fragilis*, Hyatt, perhaps all belong to the family of Spongidæ, or are to be distributed in different families of Spongidæ and Spongelidæ;—then the reader will see that after Dr. Marshall's paper the matter becomes comparable with the Gordian knot, which can no longer be disentangled but only cut asunder. This I perform in the following manner. I unite the genera *Psammascus*, *Dysidea*, and *Spongelia* into a single genus *Spongelia*, characterising it by *large* flagellated chambers—of course, as in the whole family, devoid of any special cameral canaliculi—and by the tendency to form "conuli."

Psammoclema.

This genus of Dr. Marshall[1] I adopt for the forms with *small* flagellated chambers and with the external surface smooth and devoid of any projections of the skin owing to those of the skeleton. All this is only of a temporary character; indeed, the possibility is not excluded that many good species, still undoubtedly allied amongst themselves, are all alike in the possession, for instance, of the character of forming cylindrical tubes with a well-developed central cavity, so that my species *Psammoclema vosmaeri* would have to be transferred into another new genus; but it must be remembered that in the group Keratosa all the present arrangements are but of a provisional character.

Psammopemma.

This genus, established by Dr. Marshall,[2] admits of a very sharp diagnosis. Among its representatives no horny skeleton is to be found at all, the propping apparatus of the sponge being represented by foreign enclosures exclusively. Moreover, the genus is perhaps really a good one, since, as suggested by Dr. Marshall, the possibility is not excluded that the sponges in question receive the foreign bodies in a way different from that in which they are obtained by other Spongelidæ (comp. Dr. Marshall's above-mentioned paper, p. 121). At any rate, this genus is to be referred to the Keratosa,[3] and according to the internal organisation of the soft parts to the Spongelidæ.

[1] *Loc. cit.*, p. 109. [2] *Loc. cit.*, p. 113. [3] For grounds, see p. 46.

Family Spongidæ.

The family of Spongidæ possesses a larger number of genera than any other family among the Keratosa, but it is only in Aplysinidæ that we meet with genera of such conditional characters.

Euspongia, Hippospongia, Cacospongia, Stelospongos.

The genus *Euspongia* has its own history. Established in the year 1859 by Bronn, it has been adopted by O. Schmidt, although not immediately. It was not adopted by Alpheus Hyatt, who returned to the old name of *Spongia*, auctorum, but has been again recalled by F. E. Schulze, although with a certain reserve. Prof. Schulze, though adopting this name as a generic one, still lays stress upon the fact that the genera *Euspongia* (which he characterises by fine skeletal fibres forming very small meshes) and *Cacospongia* (characterised by him as well as by O. Schmidt,[1] from whom it originates, by comparatively thick skeletal fibres and large meshes) are very closely allied to one another, and that with respect to some intermediate forms the question of whether the classifier has to do with a *Cacospongia* or *Euspongia* is to be decided only according to his individual opinion.[2] One might say that the matter is not so very complicated; one would believe that the *Cacospongiæ* and *Euspongiæ* are divergent branches of the general genealogical tree (in the sense that the skeleton presenting a supporting apparatus for the soft parts, one group of Spongidæ have adopted thick fibres and large meshes, the other fine fibres and small meshes, both kinds of skeleton being thus mechanically perhaps of equal strength), connected by the presence of all possible intermediate stages; that in some thousands of years, when the latter have died out, spongiology will have to deal with two very good genera. The matter is, however, by no means so simple, owing to the fact that each of these genera shows other special modifications, and the genus *Euspongia*, namely, in the direction which leads us to the genus *Hippospongia*, F. E. Schulze[3]; a *Cacospongia* in order to become a *Stelospongos*, O. Schmidt.[4] F. E. Schulze characterises his genus *Hippospongia* by the presence of a well-developed system of canals permeating the body of the sponge, often in such a manner that between them only comparatively thin partition-walls can be found, and further, by the absence of primary fibres which are directed in *Euspongia* and *Cacospongia* perpendicularly to the external surface, the latter character being in causal connection with the peculiarity first mentioned; the genus *Stelospongos* was established in 1870, and characterised by the differentiation of the skeletal fibres in separated columns directed in a more or less regular manner radially from the basis of the sponge towards the external surfaces, and consisting each of a compact network of vertical primary and horizontal

[1] Spong. d. adriat. Meer., p. 26.
[2] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 612.
[3] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 614.
[4] Spong. des atlant. Gebiet., p. 29.

secondary fibres, these latter also occasionally uniting the columns with one another, the fibres themselves being thick and hard. To the diagnosis given by F. E. Schulze of his *Hippospongia* I can add the following point, allowing an easy distinction to be made between the representatives of this conjectural genus, and concerning the character of the outer surface, though admitting of no examination of the outermost ends of the canals perforating the body of the sponge, but still betraying their presence by an alternation of thick and massive portions of the sarcode with spots where only very thin membrane covering the subjacent cavities is to be found. The drawing of my *Hippospongia anomala* given on Pl. VII. will illustrate my idea. This character, however, is only of practical importance. To sum up, both in *Stelospongos* and *Hippospongia* we have to deal with porous forms, the skeletal fibres of the first genus, however, admitting of a distinction into thick primary and finer secondary ones, those of the genus *Hippospongia* being on an average all of the same size and thickness; a good distinction indeed, and further, a typical *Stelospongos* has a quite different shape from that of a typical *Hippospongia*. But as stated before, the matter is by no means so very simple. As to the typical *Hippospongiæ*, I found many of them (all belonging to the species *Hippospongia equina*) in the collection of Prof. F. E. Schulze at the Zoological Institute of Graz, and I make use of this opportunity in order to express my great thankfulness to Prof. F. E. Schulze for his liberality; as to the typical *Stelospongos*, Prof. Steenstrup of Copenhagen has been kind enough to send me three specimens of it determined as *Stelospongos* by O. Schmidt himself. But together with these three specimens, Prof. Steenstrup sent me some other horny sponges (different varieties of Hyatt's *Spongia agaricina*, subsp. *dura*) distinguished also by radial columns as described before, the fibres constituting them being, however, all of the same dimensions; and again, in the Challenger Collection I find one specimen also of the same character, but with fibres thick and rigid, while those of Prof. Steenstrup's specimens just mentioned are fine and elastic. The skeleton of a typical *Hippospongia* has a rather different appearance from that of a typical *Stelospongos*,[1] but it is obvious that if the canals perforating the body of a *Hippospongia* were to assume a more regular disposition, we should have a skeleton in the form of numerous columns standing separately, which is so very characteristic of the genus *Stelospongos*. This is, as we have seen, the case both with regard to Hyatt's *Spongia agaricina*, subsp. *dura*, and again, atl east in a certain degree, with regard to the sponge of the Challenger Collection above alluded to. The first mentioned can indeed be still regarded as *Hippospongia*, the last mentioned, however, only if we enlarge the diagnosis of the genus *Hippospongia* in order to group into it forms with thick skeletal fibres. Neither is it *Stelospongos*, since its fibres do not admit of the distinction into primary and secondary ones. I ask, to which character

[1] Comp. Schulze's paper on Spongidæ, *Zeitschr. f. wiss. Zool.*, vol. xxxii. pl. xxxv. fig. 14, and Schmidt's Spongien des atlantischen Gebietes, pl. iii. fig. 13, and also my drawing Pl. VI. fig. 2.

have we to give the preference, to the differentiation of the fibres into primary and secondary ones, or to their thickness and rigidity? Through my *Hippospongia anomala*, and indeed many other still unknown forms, the genus *Euspongia* is very closely allied to the genus *Hippospongia;* through *Cacospongia mollior*, O. Schmidt, it is not less closely allied to the true *Cacospongiæ;* both *Cacospongia* and its special modification the genus *Stelospongos* being connected with typical *Hippospongiæ* by means of forms similar on the one hand to my *Cacospongia intermedia*, and on the other to *Stelospongos friabilis* and *Spongia agaricina*, subsp. *dura*, Hyatt. The reader sees that in these genera we meet the same *circulus vitiosus* as in speaking of the mutual affinities of different families of the group Keratosa, and that the classifier in numerous cases has no other guidance than his own individual opinion. A quite analogous phenomenon we find also with regard to the next genus.

Coscinoderma.

This genus was created in the year 1883, and defined by Mr. Carter,[1] by many characters of which, however, only one can claim the designation of a generic one, namely, the uniformity of the skeletal fibres as in *Hippospongia*, these fibres not admitting of the distinction into primary and secondary ones, being all of the same thickness, and not forming polygonal meshes but such as may be compared with wool-whorls. Of course the system of internal canals, so very characteristic of *Hippospongia*, is not to be found here. Mr. Carter established his genus for only one species, *Coscinoderma lanuginosum*, and characterised it, *inter alia*, by a specially differentiated dermal membrane full of foreign bodies, the fibres of the skeleton being almost free from any enclosures, and by the evenness of the external surface. In the Challenger Collection I find a specimen with the dermal membrane, like that of *Coscinoderma lanuginosum*, full of foreign enclosures, and in general, apart from the colour of the skeletal fibres, just of the same properties as the above-mentioned species, with very fine skeletal fibres, and forming no polygonal meshes. But the outer surface of this specimen proved to be uneven, owing to the sharp-pointed denticulations of the skeleton. Further, I find a specimen whose dermal membrane cannot be easily drawn off, whose skeleton meshes are polygonal, but which shows on the surface of its skeleton the same denticulations, corresponding with sharp-pointed networks of the skeletal fibres, precisely as in the specimen I have just spoken of, but whose fibres are all of the same thickness, their colour—of a paler shade in the specimen before mentioned—being, as in *Coscinoderma lanuginosum*, rather brownish, and almost entirely devoid of any foreign enclosures. And finally, I find a specimen quite different from those before mentioned in its external shape, with fibres cored with foreign bodies, but still all of the same thickness. Are all these forms really so closely allied to one another as to be united into one genus?

[1] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. xii. p. 309, 1883.

Phyllospongia, Carteriospongia.

The first of these genera was created by Ehlers,[1] the second by Hyatt;[2] both have been united by the last-named naturalist into a special family Phyllospongiadæ, characterised by the leaf-like shape of its representatives, those of the genus *Phyllospongia* being lamelliform and with the external surface quite smooth, those of the genus *Carteriospongia*, though still lamelliform, very often indeed provided with numerous lateral outgrowths, but far thicker, and probably in physiological harmony with this latter peculiarity, with the outer surface presenting on its whole extension an alternation of more or less deep elongated hollows, and more or less high, also elongated, tubercles. I also think that both these genera are closely allied to one another, but this is only my individual opinion, for while the skeletal fibres of *Phyllospongiæ*, thin and elastic as they are, recall those of *Euspongia*, the skeletal fibres of *Carteriospongia*, far thicker than the preceding and overcharged with foreign enclosures, resemble those of *Cacospongia*, the possibility is not excluded that the *Phyllospongiæ* are modified *Euspongiæ*, the *Carteriospongiæ*, on the contrary, modified *Cacospongia*. It may be further stated that the natural systematic place of *Carteriospongia* is among the Spongelidæ (comp. p. 17), while *Phyllospongia* as regards its internal organisation belongs to the Spongidæ. On the other hand, the chief point concerning their external shape seems to be also of a rather ambiguous nature, owing to the great variability of the form of the body in the group Keratosa, and particularly of the true Spongidæ. And it is very possible that though O. Schmidt[3] united *Spongionella*, Bowerbank, with his *Cacospongia*, the species *Spongionella pulchella*, Bowerbank, instead of being a British variety of *Cacospongia scalaris* as Schmidt supposes, is merely a link connecting the true Spongidæ with *Phyllospongia*. At least the figure of *Spongionella pulchella* given by Bowerbank in his Monograph[4] recalls very much that of *Spongia* (*Phyllospongia*) *papyracea* in Esper's Pflanzenthiere, the only distinction consisting in the comparative thickness of specimens which are leaf-like in both cases; and, on the other hand, it must be noticed that as to the second species of *Spongionella* described by Bowerbank (*Spongionella holdsworthii*), Carter[5] identifies it directly with *Spongia papyracea*, Esper. To sum up,—the affinities of both the genera I am speaking of are surrounded by no less uncertainty than those of the genera *Euspongia*, *Cacospongia*, &c., the generic distinctions being of the same conditional character.

Oligoceras, Hircinia, Ceratella.

The genus *Oligoceras*, established by F. E. Schulze[6] for some specimens from Lesina, is indeed one of the worst genera. Marshall[7] classes it under his Dysideidæ, and this

[1] Die Esper'schen Spongien, p. 23.
[2] Revision, &c., vol. ii. p. 540.
[3] Spong. d. adriat. Meer., Bd. ii., Suppl., p. 9.
[4] Vol. iii., pl. lxv. fig. 5.
[5] *Ann. and Mag. Nat. Hist.*, ser 4, vol. xvi. p. 193.
[6] *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. p. 34.
[7] *Ibid.*, Bd. xxxv. p. 92

proceeding would have been as natural and comprehensible had it taken place before the classical investigations of F. E. Schulze were published, as it is strange now, Dr. Marshall's paper in question having been issued in the year 1881. Dr. Vosmaer[1] places this genus in his and F. E. Schulze's family Hircinidæ, another proceeding which would be quite inexplicable, since the species of *Oligoceras* hitherto described is entirely devoid of any filaments, had it not a very simple explanation, that of an erratum. Schulze himself lays great stress on the close affinity of *Oligoceras* with *Cacospongia*, and indeed, since in its somewhat absolute character (I speak of that of the canal system) the genus thoroughly agrees with other Spongidæ, and differs from *Cacospongia* only by secondary and therefore extremely conditional characters, its natural systematic place is near *Cacospongia*. The differentiating characters above mentioned are the following: (1) the tendency to take foreign bodies into the parenchyma, and particularly on to the external surface; (2) the want of a proper network of horny fibres, the horny substance being developed so scantily that portions of the body as large as peas are completely devoid of any skeletal fibres; (3) the structure of the skeleton, its fibres being overcharged with foreign enclosures, and the skeleton on the whole being represented by isolated fibres which have only rare anastomoses and ramify widely like the antlers of a stag. Do these characters together justify the establishment of a genus, even from the naturalist's point of view, not demanding for generic distinctions differences of an absolute nature? I see, logically at least, no grounds for answering this question in the negative, since one may regard the Oligoceratidæ as a group of forms with a tendency to lose the horny skeleton entirely in order to become Myxospongidæ, or at least analogues of *Psammopemma* among the Spongidæ. *Oligoceras* has accordingly the same right to exist as a genus as *Cacospongia* or *Hippospongia*, each personifying a new principle, all being connected amongst themselves by all possible intermediate stages. From this point of view I should be obliged to adopt F. E. Schulze's genus in question; I cannot, however, do so on account of the unusually conditional nature of the characters distinguishing the Oligoceratidæ, apart from the point that the transformation of a true *Cacospongia* into a not less typical *Oligoceras* appears to be very easily realisable (comp. p. 84). The characters separating *Cacospongia* and *Euspongia* from one another are also conditional, but in this latter case at least a conventional boundary is admissible. We can, if necessary, group in *Euspongia* forms with fibres not thicker, and with meshes not larger, than a given dimension, the forms with larger meshes and thicker fibres being grouped in the genus *Cacospongia*. But even a similar, quite artificial boundary is not applicable to the distinctions between *Cacospongia* and *Oligoceras*. All Spongidæ take foreign bodies into the parenchyma as well as into the skeletal fibres, and F. E. Schulze[2] himself warns us not to ascribe to this character too great a significance. But apart from this, even did the taking in of foreign bodies represent the manifestation of an "unknown intellectual power," and were their

[1] On *Velinea gracilis*, p. 445.

[2] *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. p. 14.

number and quality thus characteristic of every sponge and not dependent on the peculiarities of the surrounding soil, it would still be practically impossible to distinguish *Cacospongia* from *Oligoceras* by these characters alone. And the third additional character of the latter would be also of very little assistance. The skeleton of *Cacospongia* is represented by a continuous network of fibres; that of *Oligoceras* is interrupted by spaces of parenchyma devoid of any skeleton, so that, on the whole, its chief fibres show a tendency to free themselves, to separate from one another in order as is the case with *Aplysilla*, and to form tree-like formations. But this character, or rather tendency, is common to all Spongidæ with skeletal fibres overcharged with foreign enclosures; in my *Cacospongia spinifera* and *Cacospongia tuberculata*, amongst fibres forming obviously a continuous network, I find fibres whose secondary ramifications do not reach the neighbouring primary fibres, so that a small tree is actually formed. In *Spongelia spinifera* F. E. Schulze[1] found a form with a still more pronounced tendency in its skeletal fibres to ramify, to lose connection with one another in order to form small tree-like structures. He did not, however, create for it a special genus. Again, as before alluded to, the conjectural generic characters of *Oligoceras* seem to be of a very unstable nature, and this is the second ground why the genus *Oligoceras* should not be adopted even provisionally.

The genus *Halispongia*, Bowerbank, being according to O. Schmidt identical with his *Cacospongia*, the genus *Ditela*, O. Schmidt, having been given up by Schmidt himself, who pointed also to the necessity of the same proceeding with respect to the genus *Auliscia*, Bowerbank, there remain only the genera *Hircinia* and *Ceratella* to be mentioned, since the names *Stematumenia*, Bowerbank, *Polytherses*, Fonbressin and Michelotti, and *Filifera*, Lieberkühn, are synonyms of *Hircinia*. The subgenus *Sarcotragus*, established by O. Schmidt in the year 1862, was abandoned by him in the following year.

As to the genus *Hircinia*, the reasons why I cannot adopt the family Hircinidæ in the sense of F. E. Schulze and Vosmaer have been stated in the foregoing pages (pp. 12–14), and indeed the grounds above mentioned which forbid us to use the presence of parasites in order to characterise the family, also forbid the use of this character for purposes of generic distinction. It is not without interest that amongst the Challenger specimens I have forms attached by filaments, some of which, according to their other properties, I must group in the genus *Stelospongos*, others in the genus *Oligoceras*, had it been retained, and others in the genus *Cacospongia*. Should we adopt the name *Hircinia* for forms with very large meshes and with fibres overcharged with foreign enclosures as Carter and Hyatt have done? I think this would be a very doubtful proceeding; the above characters are also common to *Oligoceras*, and we have

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 152.

seen that this genus cannot be adopted. The best thing that could be done would consist in a total disuse both of *Oligoceras* and *Hircinia*.

Finally, as to the Ceratelladæ, I regard their nature as sponges insufficiently proved to speak here of their place in the system. The late Dr. Gray,[1] to whom we owe the first description of these interesting beings, though classing them among the sponges, did so with the greatest reserve, "until their organisation and growth is known. At the same time," he adds, "I know no group of sponges with which they can be compared" (*loc. cit.*, p. 576). In his paper on the "Transformation of an Entire Shell into Chitinous Structure,"[2] Carter comes to the conclusion that the Ceratelladæ have absolutely nothing to do with sponges. He adopts both the genera distinguished by Gray in his family of Ceratelladæ, but he groups them in that of Hydractiniæ. Hyatt[3] is again of quite a different opinion on the matter. He considers the forms in question to be indubitable sponges, and, rejecting Gray's genus *Dehitella*, unites all the Ceratelladæ known to him in the single genus *Ceratella*. Now, so far as my own information goes—and like that of the naturalist before mentioned it is limited to the properties of the skeleton exclusively—I must confess that I can only agree with Mr. Hyatt. There is really in the skeleton of *Ceratella* nothing hydroid or coral-like; "on the contrary, the whole is thoroughly sponge-like." But this opinion can only be scientifically endorsed after an investigation of the structure of the soft parts of the animals in question, and, until we are acquainted with their internal organisation, any discussion as to their systematic place would be premature.

Family Aplysinidæ.

Apart from the genus *Dendrospongia*, Hyatt, which, if really to be adopted as an independent genus, may belong to the Darwinellidæ, the family in question contains the genera *Luffaria*, *Verongia*, and *Aplysina*.

Luffaria.

This generic name originated with Duchassaing de Fonbressin and Michelotti,[4] who have described under this designation numerous sponges from the Caribbean Sea. How far these sponges really belong to *Luffaria*, and not to *Verongia* or even *Aplysina*, is very difficult to say, the descriptions of these authors being very superficial. As a matter of fact, it must be stated that they regard the *Spongia fistularis*, Linné—illustrated in Esper's Pflanzenthiere (Bd. ii. pls. xx., xxi., xxiA.), and the specimen represented on pl. xx. is still in the Museum of Erlangen—as belonging to their newly-created genus

[1] *Proc. Zool. Soc. Lond.*, 1868, p. 575.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xi. p. 1.
[3] Revision, &c., ii. p. 550.
[4] Spongiaires, &c., p. 59.

Luffaria. Now, since for forms like *Spongia fistularis* the name of *Verongia* had been proposed by Bowerbank many years before, Hyatt, in the year 1875, rejected[1] the name *Luffaria* as identical with *Verongia*. It may be so with respect to the *Luffaria* of de Fonbressin and Michelotti, but Mr. Hyatt was wrong in not paying attention to the proceeding of O. Schmidt,[2] who in the year 1870 adopted *Luffaria*, and furnished the genus with a tolerably distinct diagnosis. He states that *Luffariæ* are sponges with skeletal fibres resembling those of a *Cacospongia* but still differing from them chiefly in three respects: —by a glass-like ("glasig") character of the fibres, by their faculty of splitting easily, and by the possession of a narrow central canal, not identical, however, with that of the true Aplysinidæ. This latter statement Schmidt illustrates by a drawing representing a fibre of a *Luffaria* highly magnified. To these three characters O. Schmidt appends a fourth concerning the structure of the network formed by the fibres. He ascertains that the fibres of *Luffariæ* are approximately all of the same size, *i.e.*, comparatively thick, and that the irregular network formed by them terminates peripherally not with an even surface but with a surface roughened by many prominent fibres, so that a portion of the skeleton if devoid of soft parts would represent something comparable to a brush. In the Challenger Collection I find two specimens, the properties of whose skeletal fibres agree with those of *Luffariæ* as described and illustrated by O. Schmidt. I found, however, that the network of their skeletal fibres, though ending peripherally in projecting fibres (Pl. IX. figs. 2 and 4), is composed not of fibres of one kind, as suggested by Schmidt, but of two kinds, of larger fibres all approximately of the same thickness and of smaller ones originating from the first mentioned, but differing from them not only in diameter but also in their histological structure, the central canal of many of these smaller fibres having been found to be inconspicuous. Whether my specimens are to be regarded as deviating forms, or whether the statement of O. Schmidt was based on an insufficient study of the skeleton of the *Luffariæ* which he had for examination, I am not prepared to say. I must add, however, that this last supposition seems to me to be very plausible, not only because the later spongiological papers of O. Schmidt do not show that attention to practical details so characteristic of his "Spongien des adriatischen Meeres," but also because a portion of the skeleton at least of the Challenger *Luffariæ*, when washed and dried, demands a microscopic examination in order to prove the presence of finer fibres, these latter being not only of a paler colour than the larger ones, and covered by them almost throughout, but also very scantily developed near the external surface. At any rate, I see no grounds for rejecting the genus in question. Thanks to the great amiability of Prof. Selenka of Erlangen, the type specimen of *Spongia* (*Verongia*) *fistularis*, Esper, has been placed at my disposal, and thus I am able to state that the difference between *Luffaria* and *Verongia*—which latter genus differs from *Aplysina* only by the compara-

[1] Revision, &c., vol. i. p. 401.

[2] Spong. d. atlant. Gebiet., p. 30.

tive thickness of the horny walls of its fibres—is greater than that between *Verongia* and *Aplysina*.

Verongia.

On page 7 I have stated the grounds which make it, though not very probable, yet not impossible, that the *Luffariæ* have perhaps nothing to do with Aplysinidæ, being only specifically modified *Cacospongiæ*. At any rate—though bearing in mind the necessity for certain concessions to the present state of our knowledge, we must necessarily place the genus in the family Aplysinidæ—the genus, owing to the fact that many of the smaller fibres of the skeleton of some of its representatives must be called homogeneous, is so very closely connected with true *Cacospongiæ* that its diagnosis can only be of a very conditional character. The same must be said with respect to the mutual relations of the genera *Verongia*, Bowerbank,[1] and *Aplysina*. Hyatt characterises his Aplysinidæ "by the regular net-like anastomosis of the fibres, the tendency of this to occur in the same plane, the flatness of the fibres, and the thinness of their walls."[2] He characterises his Dendrospongiadæ, of which the genus *Verongia* is a representative, "by the irregular anastomosis of the fibres of the skeleton, by their rotund form, and by the thickness of the horny walls."[3] As to the regularity or irregularity of the network of the skeletal fibres, the conditional nature of this character is but too evident;—it is well known what approximate expression geometrical outlines find in organised beings; again, as to the flatness of the fibres of Hyatt's Aplysinidæ, this character seems even more doubtful. F. E. Schulze has not only ascertained that the fibres of *Aplysina aërophoba* are all more or less mathematically cylindrical and their transverse section circular, but has also made it probable that the above-mentioned statement of Hyatt is due to the circumstance that the specimens he had for examination were dried, in which state all thin-walled round tubes filled with a fluid mass shrink, and form compressed tubes with transverse sections of elliptical outline.[4] Finally, so far as the comparative thickness of the fibre-walls is concerned, many of the foregoing lines have been written precisely to show that there are thick-walled fibres which show a tendency to become thin-walled, and again, in the *Aplysinæ*, fibres with the contrary tendency; we see therefore that the three characters in question—provided that Hyatt is correct as to the conjectural flatness of the skeletal fibres of the Aplysinidæ—are of a thoroughly conditional nature.

Aplysina.

The diagnosis of this genus having been already given when speaking of the preceding genus, all existing genera of the Keratosa have been presented to the reader, and I

[1] Monogr. of Brit. Spong., vol. i. p. 209
[2] Revision, &c., vol. i. p. 404.
[3] Revision, &c., vol. i. p. 400.
[4] *Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 399.

have only to summarise the foregoing observations. I do it in the following words :— *with the exception of the genera Darwinella, Ianthella, and Psammopemma, all genera are devoid of any properties separating them absolutely from one another.*

The further conclusions deducible from this statement will be given in the last part of this Report, for they will only be instructive when we shall have learned the properties used at the present time in order to distinguish and characterise the species. An abstract discussion of all such properties would lead me too far; it is besides unnecessary, since the following chapter, devoted to the description of the forms brought home by the Challenger Expedition, may serve as a better illustration of them than any however detailed but abstract discussions. Some remarks with respect to the external character of the following descriptions: as in my memoir on the Challenger Calcarea, the reader will not find any specific diagnoses; I must confess I regard them in most cases as a loss of space and time, and altogether superfluous, especially as nearly every species in the Challenger Collection of Keratosa is represented by a single specimen only, so that the tendency to vary could not be made out. As to this question in general, I refer the reader to the extremely instructive paper of Heincke on the varieties of the herring[1]; on the other hand, I invite him to peruse the diagnoses of Calcarea given by Haeckel in his "Kalkschwämme" for every species. Would he receive any idea of the animal from a similar diagnostic description? I think not. And this with respect to Sponges, the geometrical properties of whose spicules present far more tenable systematic distinctions than is the case with regard to the Keratosa. As to those described in this paper, I regard their entire descriptions as diagnoses, and end this chapter with the following observations of a practical nature.

All the specimens in the collection not devoid of soft parts have been examined with regard to their canal system and skeleton. The skeletal fibres have been examined both in spirit and mounted in Canada balsam, after previous treatment with ammonia, in order to remove the soft parts. These latter have been examined in sections stained in different ways by different staining fluids; for it must be stated that while for the Calcarea no other staining fluid but picro-carmine is to be recommended, the matter is quite different with regard to the Keratosa, so that in each case the investigator must proceed experimentally.

[1] Die Varietäten des Herings, Berlin, 1877.

III.—DESCRIPTION OF THE SPECIES.

Group KERATOSA, Grant, 1861.

Ceraospongiæ, O. Schmidt, 1862.
Euspongiæ, Duchassaing de Fonbressin and Michelotti, 1864.
Ceratina and *Psammonemata* (*e. p.*), Carter, 1875.

Porifera with horny skeleton devoid of proper spicules.

Family Darwinellidæ, Merejkowsky, 1878.

Aplysinidæ (*e. p.*), F. E. Schulze, 1878.
Aplysillinæ, v. Lendenfeld, 1883.
Aplysillidæ, Vosmaer, 1884.

Keratosa with large pouch-shaped flagellated chambers communicating by means of numerous pores on their walls with inhalent cavities, by means of one wide mouth with exhalent cavities; ground-mass without granules, transparent; axis of fibres thick.

Ianthella, Gray.

Verongia (*e. p.*), Ehlers.

Darwinellidæ, the fibres of whose skeleton contain true cells.

Ianthella flabelliformis, Pallas, sp. (Pl. I.; Pl. II. figs. 1–7).

Spongia flabelliformis, Pallas, Elenchus Zoophytorum, p. 380.
Ianthella flabelliformis, Gray, Proc. Zool. Soc. Lond., p. 49, 1869.
Verongia flabelliformis, Ehlers, Die Esper'schen Spongien, p. 11.

This species is represented in the Challenger Collection by two specimens both from the Eastern Coast of Australia; one of them may be seen drawn of natural size on Pl. I. Their shape, in accordance with the specific name of the animal, is that of a thin leaf terminating in a short stem; which latter in both cases is of irregularly cylindrical outline and about 25 mm. long by 12 mm. broad.

The Skeleton.—The constituent elements of the leaf-like part of the skeleton admit

of a distinction into primary fibres, taking their origin from the upper end of the stem in order to assume a radial direction, as can be seen on pl. xiii. of Esper's Pflanzenthiere, ii., and into secondary fibres uniting the primary ones with one another both perpendicularly and parallel to the surfaces of the sponge. Both the surfaces are uneven, and this is due to the circumstance that the secondary fibres, which are nothing but lateral branches of the primary ones, interlacing amongst themselves, form prominent irregular networks. The last-named are most fully developed near the upper end of the stem, growing gradually lower towards the edge of the leaf-like part of the animal. The external surface of this stem is comparatively smooth; its skeleton admits of no distinction into primary and secondary fibres, the whole presenting a very compact and solid network, with meshes of smaller diameter than those of the leaf-like extension (Pl. II. fig. 3). The fibres themselves, as is well known, are heterogeneous and, on the whole, to be classed as thick walled. The microscopical structure of the central pith-substance does not differ from that of *Aplysina*, as described by F. E. Schulze[1] in the case of *Aplysina aërophoba*, nor do the walls surrounding this central differentiation, and presenting, as is always the case, many layers of concentrically disposed horny laminæ, with the sole distinction that between these latter true cells are to be found in abundance. As to the histological properties of these interlaminar elements, I refer the reader to Dr. Flemming's[2] paper on *Ianthella*, for I can confirm all his statements except as to the ends of the fibres being, as he suggests, devoid of cells. For my own part, I could always discern them even on the youngest fibres, viz., on the fibres with only a very thin horny envelope, and am able to state that they are absent only at the ends of developing fibres, represented by pith-substance surrounded immediately by spongoblasts. That the cells enclosed in the walls are nothing but transformed spongoblasts is beyond doubt, but of course this will be actually proved only when direct observations on the actual process of development of the fibres in question have been made. For myself, amongst the elongated spongoblasts, as I have drawn them on Pl. II. fig. 5, I have very often seen cells of a more massive and also compressed form, and I believe these to be intermediate stages between the typical spongoblasts and the interlaminar cells. But I have not figured them, because their deviating appearance may yet be ascribed to the influence of the preserving fluid. Around the "mantle of spongoblasts" of young fibres I always found aggregations of mesodermic cells, though by no means always disposed parallel to the developing fibre as drawn and described by v. Lendenfeld[3] in his *Dendrilla rosea* and *Dendrilla aërophoba*. Around old fibres I have missed them completely. According to Flemming, the colour of the fibres of *Ianthella basta*, so far as the horny substance of their laminæ is concerned, is yellow, that of the enclosed cells deep violet. I have found in most cases the colour of the laminæ also to be violet. I am, however, inclined to ascribe this merely to the

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 401, pl. xxii. fig. 11.
[2] *Würzburg Verhandl.*, N. F., Bd. ii.
[3] *Zeitschr. f. wiss. Zool.*, Bd. xxxviii. p. 286; pl. xiii. figs. 25, 28, 29.

influence of preservation in alcohol. I think that the colouring substance, by which the spongoblasts (if not all the cells of *Ianthella*) are coloured in the living state, is soluble in spirit, and might thus when dissolved have coloured the true horny substance also; for, while I found most of the fibres of a violet colour, and containing violet cells, I found also fibres whose cellular elements were of a deeper colour than usual, and that of the horny laminæ considerably paler.

The Soft Parts.—As to the anatomy of its soft parts, the species differs but little from *Aplysilla*, *Dendrilla*, and *Halisarca dujardini*. Both the surfaces of the sponge when examined with the naked eye show a great number of groups of openings, as represented on Pl. II. fig. 1, under a low magnifying power. These are the oscula, each being usually represented by four or five apertures. The parts of the membrane between them, when seen under the microscope, show themselves as usual to be provided with numerous minute pores. The water entering through these *pori dermales* reaches the cavities under the covering membrane, and passes from these latter by means of *pori camerales* into the flagellated chambers, in order to be expelled through a large mouth into exhalent canals, finishing with the oscula above mentioned. Thus each osculum, with its pores and its subdermal or inhalent cavities, flagellated chambers, and exhalent cavities, presents an independent whole, which may be compared with a state in a federal republic. The inhalent and exhalent canals are of very irregular outline; they may be very large and short, very narrow and long, &c.

The form of the flagellated chambers is also very variable. Its mathematical mean shape is expressed by the two flagellated chambers on Pl. II. fig. 5. But though such regular pouch-shaped flagellated chambers may be found without difficulty, the outlines of most others are quite irregular (comp. Pl. II. fig. 4). Sometimes they are cylindrical and elongated, sometimes irregularly roundish, often provided with secondary ramifications; their size is inconstant.

Now so far as the histological structure of the present species is concerned, it is constant to the general type prevailing among the Keratosa, presenting, however, a few new peculiarities. The ectodermic pavement-epithelium could be discerned only on the surfaces of the inhalent canal system. My endeavours to make it out on the external surfaces were unsuccessful, owing probably both to the state of preservation and to the fact that the external surfaces above mentioned are covered by a thin cuticle such as Schulze[1] has described in *Cacospongia cavernosa*. No distinction can be detected between the ectodermic and endodermic pavement-cells. In all cases they are flat, irregularly polygonal, with a comparatively small nucleus, and showing the protoplasmic granules only around the nucleus. As to other representatives of the endoderm, viz., flagellated cells, they seem to agree as regards their form with those of *Aplysilla*,[2] but it must be noticed that the flagellated cells are very sensitive to every method of preservation,

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 654.

[2] *Ibid.*, Bd. xxx., pl. xxiii. fig. 26.

and that their properties can be studied with success only in the living state. The constituent parts of the mesoderm are as usual represented by a transparent ground-mass, by stellate or fusiform cells and cellular elements of amœboid character. The amœboid cells differ from the first-mentioned apart from their general shape by their nucleus being comparatively larger. It is generally accepted that the amœboid cells in the sponges give origin to the generative products; both the specimens of *Ianthella* proved, however, to be sterile; in one of them, indeed, I found here and there large egg-shaped bodies, but since I did not succeed in discerning in them anything like a nucleus, I am far from being sure whether they were really ova or something else. The stellate mesodermic cells, as well as those of fusiform shape, do not differ from those of *Sycon raphanus* as described by F. E. Schulze,[1] but it must be said that while their fusiform modification is very seldom found in *Sycon raphanus* and the Calcarea generally, it is far more common in *Ianthella* than the stellate form. Particularly near the outer surfaces these fusiform, probably contractile, cells are very numerous, surrounding in rows the pores and oscula (Pl. II. fig. 6). I have spoken of them in their special modification as spongoblasts before, and it only remains for me to mention the interesting hypodermic elements, without entering upon the discussion of the question as to whether they are really modified stellate and not amœboid cells. At any rate they are larger than both the stellate and the amœboid ones, and their protoplasm is far richer in granules. It is indeed difficult, when seeing these elements lying separately amid fusiform muscle-cells (as drawn on Pl. II. fig. 6), to resist the idea that these elements are of a nervous nature, and their histological properties, so far as they could have been studied from the material preserved in alcohol, agree tolerably well with what we regard as typical nerve-cells. I must say, however, that I was unable to discern any connection between them and the fusiform cells, and on the whole consider their nervous nature to be as doubtful as that of certain mesodermic cells described by Sollas[2] in *Thenea muricata*, as well as that of the anastomosing "Stränge" discovered by F. E. Schulze[3] in the Spongidæ. I believe these cells to be equivalent to the gland-cells stated by v. Lendenfeld[4] to be present in his South Sea Aplysinidæ, and five years before by Merejkowsky[5] in his *Halisarca* (*Oscarella?*) *schulzei*. I have found similar cells in *Aplysilla sulphurea* and *Darwinella aurea*, and I am the more inclined to compare the enigmatic elements of *Ianthella* with these gland-cells, since, as I remarked before, the external surface of this sponge is covered by a thin cuticle. Of course they are larger than common spongoblasts, while the gland-cells of v. Lendenfeld agree with these latter both in shape and size, but this difference seems to me to be of no great importance. The best methods for rendering these, as well as hypodermic fusiform cells, visible are eosine and gold, for which latter the alcohol must be previously extracted.

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxv., Suppl., p. 253.
[2] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. ix. p. 446.
[3] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 629.
[4] *Ibid.*, Bd. xxxviii. p. 278.
[5] *Mém. Acad. Sci. St. Petersb.*, vol. xxvi. No. 7, pl. ii. fig. 9.

Colour.—Violet.

Habitat.—Station 188, September 10, 1874, lat. 9° 59′ S., long. 139° 42′ E.; depth 28 fathoms; green mud.

Family Spongelidæ, F. E. Schulze, 1878.

Dysideidæ, Gray, 1867, and Marshall, 1881.
Arenosa, Carter, 1875.
Spongiadæ (*e. p.*), and *Hirciniadæ* (*e. p.*), Hyatt, 1877.

Keratosa with flagellated chambers of more or less regularly roundish outlines, communicating by means of numerous pores in their walls with inhalent, by means of one wide mouth with exhalent, cavities; ground-mass transparent, without granules. Axis of fibres thin; fibres cored in most cases with foreign enclosures.

Spongelia, Nardo.

Dysidea, Johnston.
Spongelia, *Dysidea*, and *Psammascus*, Marshall.

Spongelidæ with large flagellated chambers; outer surface provided with conuli.

Spongelia spinifera, F. E. Schulze.

Spongelia spinifera, F. E. Schulze, Zeitschr. f. wiss. Zool., Bd. xxxii. p. 152, 1878.

This species, established by F. E. Schulze in the year 1878 for some forms from the Adriatic, is characterised by him as follows:—"The conuli, 5 to 8 mm. high, situated at equal distances from one another, run out in simple thorn-like processes; among the simple ramified primary fibres no communicating secondary fibres are to be found, so that accordingly the skeleton forms no network." The chief character, since the size of the conuli is in other representatives of the genus variable, is thus the dendroid ramification of the skeletal fibres which do not anastomose with one another. In this chief character both the Challenger specimens, which I have determined as *Spongelia spinifera*, agree; but while one, differing from the Adriatic forms as regards its lower conuli, agrees with them in its mode of growth, being found like them in the form of a crust, the second specimen differs from them even in this latter point, presenting a laterally compressed leaf 25 mm. high, 20 mm. broad, and 5 mm. thick in the middle, and rather thinner near the border. The conuli of *both* the specimens do not exceed 4 mm. in height, and in accordance with this peculiarity I propose to establish for them an independent variety—*parviconulata*, while the designation *magniconulata* might be used for forms like the Adriatic *Spongelia spinifera*. No peculiarities of consequence were noticed with regard to the structure of

the soft parts; the oscula, scanty in the incrusting specimen, proved to be thoroughly deficient in that of leaf-like shape; one of the specimens proved to be sterile; the other was provided with numerous sperm-balls. The habitat of *Spongelia spinifera*, hitherto found only in the Adriatic, is now extended to the east coast of Australia.

Colour.—Pale greyish and dirty yellowish.

Habitat.—Off Port Jackson, depth 7 fathoms.

Spongelia pallescens, O. Schmidt (Pl. III. fig. 1).

This species, whose detailed definition we owe also to F. E. Schulze,[1] has been divided by him into two subspecies, and each subspecies in its turn split into two varieties. The numerous Challenger specimens of *Spongelia pallescens* are all to be determined as subspecies *fragilis* var. *ramosa*, but I must add that while the diagnosis of this variety as given by F. E. Schulze is thoroughly applicable to the Challenger specimens, the meshes of their skeletons proved to be of rather larger diameter than those of any of the Spongelidæ with anastomosing fibres examined by F. E. Schulze, and whose skeletons, through his kindness, have all been placed at my disposal. Whether this difference is of individual or varietal or even specific value, I am unable to decide, and therefore limit myself to merely mentioning it.

Colour.—Pale yellow and lilac.

Habitat.—Bahia, shallow-water.

Spongelia horrida, Selenka (Pl. III. fig. 2).

Spongelia horrida, Selenka, Zeitschr. f. wiss. Zool., Bd. xvii. p. 566, pl. xxxv. figs. 1–4, 1867.

This species, placed by Selenka in the genus *Spongelia*, has also been adopted by F. E. Schulze,[2] but apparently only on account of its form and the properties of the skeleton. I am pleased to be able to sanction this proceeding, as the external shape and structure of the skeleton of the Challenger specimens agree closely with those of the forms described by Selenka, and their internal organisation is that of a typical *Spongelia*. The identification of the forms in question is, on the other hand, confirmed by the fact that both the Challenger and Selenka's specimens were from Australia.

The Challenger Collection possesses three specimens of *Spongelia horrida;* two are in the form of crusts 12 to 18 mm. high, the third being of a more massive appearance. But all three specimens are equally constant to the main character of the species, the meshes of their skeleton being far larger than in any other *Spongelia*, as may be seen on Pl. III. fig. 2. The foreign enclosures of the fibres proved to be chiefly

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 154, 1879.

[2] *Ibid.*, Bd. xxxii. p. 122.

fragments of spicules and small sand-grains; the capsules with cellular elements found within the fibres by Selenka (*loc. cit.*, p. 566, pl. xxxv. figs. 3–4) were not to be seen.

Colour.—Pale yellowish.

Habitat.—Station 186, September 8, 1874, lat. 10° 30′ S., long. 142° 18′ E.; depth 8 fathoms; coral mud.

Psammoclema, Marshall.

Spongelidæ with small flagellated chambers; external surface smooth.

Psammoclema ramosum, Marshall (Pl. III. fig. 8; Pl. IV. fig. 1).

Psammoclema ramosum, Marshall, Zeitschr. f. wiss. Zool., Bd. xxxv. pl. vii. fig. 12, 1880.

It is sufficient to compare the drawing of this form given by Marshall with that given by me on Pl. IV. fig. 1, in order to become persuaded of the fact that both the Challenger and Dr. Marshall's specimens belong to the same species. There are, however, in the description which Dr. Marshall gives of his specimens, two points at variance with my observations, but I am inclined to explain one of them by a mistake on the part of Dr. Marshall, and the other by a real difference in organisation but of no essential nature.

It has been stated by Marshall that the skeleton of his *Psammoclema ramosum* is tree-like, the main fibres sending lateral branches which ramify in their turn but form no anastomoses. I can state the same with respect to the *upper ends* of the branches of the animal, but so far as other parts of its body are concerned, I discerned the anastomoses clearly (Pl. III. fig. 8). Again, Dr. Marshall believes the canal system of this species to be of special interest. He says: "Die Mundöffnungen befinden sich alle auf einer Seite, wie bei manchen Formen von *Halichondria oculata*, Grant, und bei *Veluspa polymorpha* var. *digitata*, Miclucho. Es scheint dies dafür zu sprechen, dass der Schwamm nicht aufrecht wächst, sondern wie viele Pflanzen im Meere, horizontal. Ein aufrechtes Wachsthum dürfte wohl auch schon bei der Schwere des Schwammes seiner geringen Festigkeit und Widerstandsfähigkeit gegenüber unmöglich sein."[1] Indeed, on some branches of the Challenger specimen the oscula were all found on the same side, but on others they were scattered everywhere, and having examined the external surface of the specimen, I found all its parts equally smooth and clean. I must therefore differ from Dr. Marshall with regard to his conclusion as to the kind of growth of the animal. I think it grows vertically, and am inclined to believe that the peculiarity in the disposition of the oscula on Dr. Marshall's specimens is characteristic only of the individual. For a more detailed description of the animal, I refer the reader to the paper of Dr. Marshall above mentioned, and will only add that its flagellated chambers agree closely as regards form and size with those of my *Psammoclema vosmaeri* (Pl. III. fig. 6), and that, on the

[1] *Loc. cit.*, p. 112.

whole, its internal organisation does not differ from that of the representatives of the genus *Spongelia*, except in the size of the flagellated chambers. What Dr. Marshall means by the words, "Das Gastrovascular-System ist hier nach dem astförmigen Typus angeordnet" (*loc. cit.*, p. 113), is of course to be regarded as an echo of corresponding erroneous statements of Prof. Haeckel. For any fine histological examinations the Challenger specimen proved to be insufficiently preserved. The Alga found by Marshall in all the specimens he had for examination was found to be characteristic also of the single specimen collected by the Challenger.

Colour.—Grey, skeletal fibres white.

Habitat.—Station 162, April 2, 1874, off East Moncœur Island, Bass Strait; depth 38 fathoms; sand and shells. Dr. Marshall's specimens were also obtained from Bass Strait.

Psammoclema vosmaeri, n. sp. (Pl. III. figs. 5 and 6).

This interesting species has been found in one colonial specimen, which is depicted of natural size on Pl. III. fig. 5. Some individuals of the colony are mouthless, the oscula of others are very small, and others again present cylindrical tubes, the diameter of the oscula being thus the same as that of their body in its different parts.

The surfaces of the sponge though entirely devoid of any conuli, are still rather uneven and rough, but whether this is due to the state of preservation or is characteristic of the species I cannot judge. The skeleton, when seen from the outer surface, admits of no distinction into primary and secondary fibres, the network of the fibres being very compact, *i.e.*, the meshes of a very small diameter, and it is only on the inner surface that the vertically directed primary fibres, 0·16 mm. thick on an average, are easily distinguishable; most of the fibres, and particularly the larger ones, are charged with foreign enclosures to such a degree that the enveloping horny substance is very thin and the surface of such fibres very rough. When dried the skeleton becomes hard and of a greyish colour. The type of the canal system and the histological structure do not differ from those, for example, of *Spongelia pallescens*, except that the flagellated chambers are of smaller dimensions and comparatively more constant in their roundish form, and that the internal cavity in some individuals is very large. Through the pores of the outer surface the water reaches the system of inhalent canals, flagellated chambers and exhalent lacunæ opening by comparatively small holes into the internal cavity.

From all other representatives of the genus hitherto known this species can be readily distinguished both by its external shape, which is more like that of a calcareous than a horny sponge, and by the compact network of its skeletal fibres, also perhaps by the tendency to form colonies.

I dedicate the species to Dr. G. C. J. Vosmaer of Naples.

Colour.—Pale greyish-yellow; skeletal fibres dirty greyish.

Habitat.—Station 186, September 8, 1874, lat. 10° 30′ S., long. 142° 18′ E.; depth 8 fathoms; coral mud.

Psammoclema foliaceum, n. sp. (Pl. III. fig. 7).

Like *Psammoclema ramosum*, the species in question was brought home in fragments, all, however, in both cases belonging to one specimen. When put together, the fragments of the Challenger *Psammoclema foliaceum* form a whole which may be compared with my drawing of *Carteriospongia radiata*, but which is approximately four times as large, with walls from two to four times as thick in different parts of the body, and with surfaces of a rather shagreen-like appearance and not distinguished by the system of longitudinal ribs. The resemblance in the form; the fact that, as regards the anatomical structure of the canal system, *Psammoclema* is closely allied to *Carteriospongia;* and again, that most of the representatives of this latter genus also possess fibres full of foreign enclosures; all render the form I am now describing extremely interesting from a phylogenetic point of view. This has led me to make greater endeavours to find out its histological structure in the hope of discovering in it the anastomosing "Stränge" of F. E. Schulze, the function of which is of course doubtful, but which are so very characteristic of *Carteriospongia* and of all the Spongidæ generally. The specimen proved, however, to be so very badly preserved that I had to be content with making out its anatomical organisation, and thus assigning to it a definite systematic position.

A portion of its skeleton is represented on Pl. III. fig. 7; like that of *Psammoclema vosmaeri*, it is of a dirty-greyish colour, due to the abundance of foreign enclosures in its fibres, but the meshes are larger, and when seen against the light the primary fibres become very clearly visible. I characterise the species exceptionally by its external shape, but of course I am uncertain whether I am right in this proceeding. Later investigations will decide the question.

Colour.—Black; skeleton grey.

Habitat.—Station 162, April 2, 1874, off East Moncœur Island, Bass Strait; depth 38 fathoms; sand and shells.

Psammopemma, Marshall.

Spongelidæ without any differentiated skeletal fibres, the supporting skeleton being represented by foreign enclosures lying separately in the parenchyma, and the secretion of the horny substance having been reduced to the formation of only a thin envelope around the enclosed foreign bodies.

Psammopemma densum, Marshall (Pl. III. figs. 3, 4).

Psammopemma densum, Marshall, Zeitschr. f. wiss. Zool., Bd. xxxv. p. 116, 1880.

When characterising this species, Dr. Marshall did not feel quite certain whether he was really describing a sponge and not a worm-tube or something of that kind. Of course, I have scarcely the right to express an opinion on this delicate question, still I believe it to be a sponge; at any rate I can state with the greatest certainty that such sponges, *i.e.*, sponges without any differentiated skeletal fibres but still secreting horny substance, do really exist. Sanctioning thus the establishment of the genus *Psammopemma*, I adopt also Dr. Marshall's species *Psammopemma densum*, since its specific designation is very characteristic of two specimens in the Challenger Collection, and especially of that from Port Jackson.

This last specimen is represented in Pl. III. fig. 3, and it will be obvious from this drawing that the original is probably not the whole animal but only a fragment of it. Now even if this fragment give no precise idea as to the shape of the whole animal, it must still be assumed that this latter was of a plate-like compressed form, supposing the fragment in question was not merely an outgrowth; while the external shape of the second Challenger specimen, represented also only by a fragment, must have been either crust-like or massive, the plane of the fracture being parallel to its outer surface.

So far as this latter is concerned, it is in both specimens uneven and throughout its whole extent rough, owing to prominent sand-grains, often 1 mm. in diameter. In the Australian specimen, at one point on its surface, I found a shallow depression, which I am inclined to regard as the osculum; but I refrained from trying to prove it by immediate dissection lest I should destroy the specimen in vain, the sponge presenting such a compact aggregation of sand-grains that only very thick sections could have been obtained from it by the microtome. Besides, the question is of little consequence.

In contrast to the specimens which Dr. Marshall had for examination, both the Challenger specimens proved to be free from any parasitic inhabitants, as well as from any skeletal fibres, either foreign or produced by the sponge itself. Nor can I say that the foreign enclosures are held together by protoplasm as stated in Marshall's definition of the genus (*loc. cit.*, p. 113); each of them, though surrounded by a thin horny envelope, having been found lying separately in the parenchyma. That the envelope just mentioned is of a horny nature I judge from the fact that it does not differ from the envelopes to be found around foreign enclosures in other Spongelidæ, lying free in the "sarcode," these latter in their turn not differing from the envelope of true skeletal fibres overcharged with foreign bodies. Contrarily to Marshall (*loc. cit.*, p. 114), I find this envelope to be

quite devoid of any enclosed corpuscles. As to the foreign enclosures themselves, they are represented in both the Challenger specimens almost exclusively by sand-grains, some of Dr. Marshall's specimens having proved to be also very rich in them, while others, on the contrary, were poor in sand and rich in fragments of mussel-shells. I agree entirely, however, with Dr. Marshall as to the impossibility of paying any systematic attention to such differences. Of course the faculty has been ascribed to sponges of choosing from the available foreign bodies those which they need. Haeckel adopts it with respect to his *Physemaria;*[1] and Carter, though on a different occasion,[2] speaks also of "that developmental intelligent power whose existence in every organised product is only known to us by its manifestations." However, the contrary opinion, held by F. E. Schulze and Marshall, is supported by more valid arguments, and there is absolutely no necessity for introducing into our scientific calculations a new thoroughly unknown factor, while the phenomenon admits of a very simple and plausible mechanical explanation.

So far now as the anatomy of the form in question is concerned, Marshall believes the *Psammopemmata* to be of very low organisation, and if I understand him aright, he sees it in their lipostomy and lipogastry. These two peculiarities, provided that the lipostomy be really characteristic of the genus, are, however, of very subordinate significance; a lipostomic and lipogastric Leuconid is yet more highly organised than a Sycon provided with the broadest central cavity and with an osculum fringed with the most elegant spicules,—such questions, without knowledge of the structure of the canal system, not being at all capable of solution. That of the *Psammopemmata* agrees in its features closely with that, for instance, of *Spongelia pallescens*, as described by F. E. Schulze. The flagellated chambers are large, of more or less regularly roundish outlines, and devoid of any special cameral canaliculi; the ground-mass surrounding them is transparent and without granules (Pl. III. fig. 4). There is also a close resemblance to the representatives of *Spongelia* in the histological properties, the only difference being that such aggregations of fusiform cells as Schulze[3] describes for *Spongelia avara* are not to be found in the two Challenger specimens of *Psammopemma*. In this statement I differ from Marshall, who lays stress on their constant occurrence in (under ?) the covering dermis. I find these fusiform cells scattered everywhere and also under the dermal membrane, but in most cases lying isolated, and never in such mutually parallel disposition as in Marshall's illustration (*loc. cit.*, pl. viii. fig. 10). Nor can I agree with him as to this dermal membrane being homogeneous (*loc. cit.*, p. 113). I found it to contain nuclei disposed at approximately equal distances from one another, and on the ground of numerous analogies I am inclined to regard it as a common pavement-epithelial layer, the boundaries of its separate cells having disappeared owing to the preservation in alcohol.

[1] Biolog. Studien, Heft. ii. p. 213.

[2] I refer to his discussion of the process of the horny skeletal fibres taking in and enclosing the foreign bodies, *Ann. and Mag. Nat. Hist.*, ser 5, vol. viii. p. 113.

[3] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 136.

The reader sees that there are many points in which I disagree with Dr. Marshall. Most of the contradictions are, however, insignificant, and the remaining ones, I feel certain, are to be explained by the fact that Dr. Marshall's specimens were either in a dried state or very badly preserved. At any rate, I see no reason against adopting both the genus and the species.

Colour.—Sandstone-yellowish.

Habitat.—Station 49, May 20, 1873, lat. 43° 3′ N., long. 63° 39′ W.; depth 85 fathoms; gravel and stones. Off Port Jackson, 7 fathoms.

Psammopemma porosum, n. sp.

In his paper on systematic rules Strickland suggests that generic and specific designations should be given which allude to the main generic or specific character of the given form;—very good counsel indeed, yet it occurs but too often that whilst following it the classifier creates very unfortunate systematic designations, and so far as the species I am going to describe is concerned, I feel by no means certain that—just as we find *Ancorinæ* without any anchor-like spicules—specimens of *Psammopemma porosum* will be found of no less density than that of the Challenger specimen of *Psammopemma densum* from Port Jackson. Still I do not take refuge in naming the species in question according to its second and undoubtedly more important character, for this latter character may prove to be of a subgeneric consequence. The species is represented in the collection by numerous small fragments, which, formless as they are, show distinctly that the external shape of the specimen—or, perhaps, specimens—dredged by the Challenger must have been of a rather stout, massive appearance. Apart from this character as well as from the porosity, which latter peculiarity may stand in connection with the massive shape of the animal, the fragments in question recall vividly as regards their form the Challenger specimens of *Psammopemma densum*, and especially that from Nova Scotia. Their colour is a dirty sandstone greyish, and the presence in the parenchyma of foreign enclosures (chiefly sand-grains, and, only in the upper skin, fragments of spicules) is well marked in the roughness of the surfaces.

As I remarked before, one of the characters of the species may be its porosity. I have but to add that this peculiarity must be really regarded as characteristic at least of the specimen, for there is no reason to suggest that the parenchymal cavities in question are due to worms as in the specimens of *Psammopemma densum* examined by Dr. Marshall. Except a Hydroid (*Aglæophenia*, sp. ?) rooting in one of the fragments and the doubtful round bodies to which I shall refer later, I miss any parasitic inhabitants entirely.

The second peculiarity characterising this form is the minuteness of its flagellated cells, which are smaller than in any horny sponge hitherto described. It is only in some Corticatæ (*Stelletta grubei, Geodia gigas, Ancorina aaptos, Tethya lyncurium*) that I

have seen these elements so strikingly minute. This peculiarity renders the sections of them readily distinguishable under the microscope from those of any other Porifera, and my first idea when examining the preparations of *Psammopemma porosum* was that this form might represent an offspring of the family above mentioned. Yet an attentive examination showed that the species has even more right to be referred to the Keratosa than *Psammopemma densum;* for while in this latter form the horny substance enveloping the foreign enclosures has been found in the form of an extremely thin layer, so that its presence beyond doubt could only be proved in most instances after treatment with hydro-fluoric acid, here in *Psammopemma porosum* it proved to be far more fully developed, and occasionally with very conspicuous outgrowths.

On p. 17 I have shown that on the whole, as the canal-system reaches a higher degree of development, the size of the flagellated chambers gradually diminishes. Of course the flagellated chambers of *Psammoclema vosmaeri* are not larger than those, for instance, of *Euspongia officinalis*, and yet they are devoid of special cameral canaliculi, but every rule has its exceptions. *On the whole*, the above dependence is still to be observed, and it is not without interest that as flagellated chambers become smaller and smaller the flagellated cells in their turn grow gradually more and more minute. The flagellated cells of *Aplysilla sulphurea* are larger than those of *Spongelia elegans*, which again are larger than the flagellated cells of *Cacospongia scalaris* or *Aplysina aërophoba*. But, as in the preceding case, exceptions are not wanting here also; *Ianthella flabelliformis* does not deviate in the structure of its soft parts from the type characterising *Aplysilla sulphurea*, and yet possesses flagellated cells of far smaller dimensions than those of the form just mentioned. Again in *Euplectella aspergillum*, in spite of its large, radial tube-like flagellated chambers, these cells are very minute. *Psammopemma porosum* presents, in this respect, the most interesting exception. As stated before, its flagellated cells are very small; while for instance in *Cacospongia scalaris* the diameter of their transverse section is 0·0025 mm., on an average in *Psammopemma porosum* it does not exceed 0·001 mm.; and yet its flagellated chambers, although smaller than those of *Psammopemma densum*, are rather larger than those of *Cacospongia scalaris* or *Euspongia officinalis*. The explanation of this curious deviation must be of course left to later investigations, but there can be scarcely any doubt that, if not even of a subgeneric importance, at any rate it necessitates the establishment of a new species, although on the whole the internal organisation of *Psammopemma porosum* agrees closely with that of *Psammopemma densum*. As a probably accidental peculiarity I can notify the presence in the parenchyma of numerous round bodies, with an average diameter of 0·012 mm., which at first sight recall vividly the spermospores of Calcarea or Aplysinidæ (p. 72). Under high microscopic power these bodies proved however to be devoid of any covering cell, and though their contents are apparently cellular elements and their size approximately the same as that of the spermospores of

Verongia hirsuta (?) or *Verongia tenuissima* (?), I yet incline to the belief that they stand in no connexion with the sponge organism.

Colour.—Sandstone yellowish-grey.

Habitat.—Bahia, shallow water.

In addition to the well-marked Spongelidæ just described, there are in the Challenger collection three specimens probably belonging also to the family in question, but so very badly preserved that there are no soft parts on their skeleton. I believe it advisable to abstain entirely from their detailed description. I think that an undescribed form is of greater profit to science than a form described insufficiently for subsequent recognition. I *believe* the sponges just mentioned belong to the Spongelidæ, but the question whether a sponge belongs to this or that family in the Keratosa cannot be decided from the properties of the skeleton alone. Again I cannot describe them only as species; the external shape plays a great part in the specific description, but the exterior of the sponge is influenced by the properties of its soft parts, and these as mentioned before are entirely absent. An entire abstinence from any description seems to me therefore to be the best plan.

Family Spongidæ.

Spongiadæ and *Hirciniadæ*, Gray, 1867.
Bibulida and *Hircinida* (*e.p.*), Carter, 1875.
Spongiadæ (*e.p.*), *Hirciniadæ* (*e.p.*), and *Phyllospongiadæ*, Hyatt, 1877.
Spongidæ and *Hircinidæ*, F. E. Schulze, 1879.

Keratosa with small hemispherical flagellated chambers, communicating by means of numerous pores with inhalent, by means of special canals with exhalent, cavities. Axis of fibres thin; ground-mass in the neighbourhood of the flagellated chambers granulated.

Coscinoderma, Carter.

Spongidæ with skeletal fibres admitting of no distinction into primary and secondary ones.

Coscinoderma confragosum, n. sp.

"Battledore-shaped, covered with a white continuous cribriform incrustation; surface even, with fibres almost uniformly alike in size and colour, viz., very small and fine, very long, scantily branched, curled up together in little whorls, of a deep sponge colour." In these words Mr. Carter[1] characterises his genus *Coscinoderma*, and together with it his species *lanuginosum*. The species I am about to describe agrees very well with that description, but presents the following differences. When bisected longitudinally the

[1] *Ann. and Mag. Nat. Hist.*, ser. 5., vol. xii. p. 309, 1883.

form of the section may be compared with a battledore, though the stem must be called very thick, and besides ends with a basal extension; but only as regards the plane of the section, the whole not being compressed, but of a massive form and of rather roundish outline. The colour of the incrustation is not white but pale greyish; and the colour of the skeletal fibres is only straw-yellow. Again, I cannot call the outer surface of my specimen unconditionally even; at anyrate the surface of the skeleton devoid of soft parts is denticulated; these denticulations are not, however, the terminal points of single fibres, but whole networks in the form of sharp-pointed projections. All these peculiarities together, and particularly the formation of sharp-pointed projections on

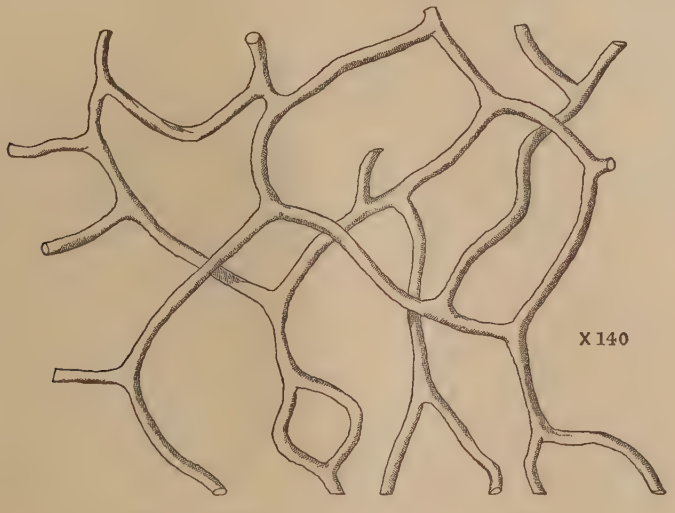


Fig. 1.—Skeletal fibres of *Coscinoderma confragosum.*

the surface of the skeleton, quite absent in *Coscinoderma lanuginosum*, Carter, necessitate the establishment of a new species. In the accompanying diagram a portion of the skeleton is represented in order to show the manner in which the fibres interlace with one another. The fibres themselves are entirely devoid of any foreign enclosures, and their average thickness is 0·015 mm. The species is represented in the collection by a single specimen, dredged by H.M.S. "Porcupine."

Colour.—Outer surface greyish, parenchyma pale grey-yellowish, skeletal fibres straw-yellow.

Habitat.—H.M.S. "Porcupine," Station 13, 1870, off the coast of Portugal; depth 220 fathoms.

Coscinoderma denticulatum, n. sp. (Pl. VI. fig. 4).

This species, also represented by a single specimen, agrees with *Coscinoderma confragosum* as regards the formation of sharp-pointed projections of the skeleton, though

here they are visible also when covered with soft parts, so that the outer surface of the sponge is distinguished throughout by small conuli 0·2 to 0·33 mm. high, the average distance between them being 1 mm.; but it differs both from *Coscinoderma lanuginosum* and *Coscinoderma confragosum* with respect to the character of its surface, which has no special superficial incrustation, the skin not differing from that of *Euspongia* or *Cacospongia*, and the manner in which the fibres form meshes. As in most other Spongidæ, the meshes are here polygonal, although still formed by fibres all of the same size—on an average 0·042 mm., *i.e.*, almost three times as thick as those of *Coscinoderma confragosum*—a new character distinguishing this species both from *Coscinoderma lanuginosum* and *Coscinoderma confragosum*. The average size of the meshes is 0·25 mm. In external shape the specimen representing this new species in the Challenger collection is in the form of a crust, but with local thickenings 10 mm. in height. In contrast to the Challenger specimen of *Coscinoderma confragosum*, which shows a very well developed osculum, no oscula can be discerned on the surface of this specimen.

Colour.—Soft parts pale greyish, skeletal fibres brownish-yellow.

Habitat.—On the reefs Honoruru, Sandwich Islands; depth 40 fathoms.

Coscinoderma altum, n. sp. (Pl. V. figs. 4–6).

This species is a good species also, provided of course that the genus *Coscinoderma* be good. The meshes of the skeleton, as in the species just described, are of polygonal outline, but on an average twice as large, the fibres themselves being one and a half times as thick. Unlike all other representatives of the genus hitherto known, the fibres are abundantly charged with foreign enclosures, so that they appear of a rather dirty-white colour. Again, the external appearance of the sponge itself is novel, and is perhaps not devoid of systematic importance. While in the two preceding species we have had to deal with forms either incrusting or massive, *Coscinoderma altum* is found in the form of a long cylindrical stalk with rounded upper end 230 mm. high and about 18 mm. broad, with denticulated outer surface, the prominences 0·75 mm. high and 2 mm. apart being however rather blunt, and the skin itself presents the same appearance as that of *Aplysina aërophoba* as drawn by F. E. Schulze.[1] The specimen contained numerous Morulæ, and I make use of this opportunity in order to turn attention to a peculiarity which, in a still higher degree, I have very often observed in *Cacospongia* and *Euspongia*, as mentioned in my paper "Ueber die Spermatogenese bei *Sycandra raphanus*," but which, as far as I am aware, is hitherto undescribed. I mean the extraordinary growth of the endothelial cells surrounding the growing embryos. They do not differ in size from other parenchyma-cells when young, but as they grow they do not become like the pavement-cells, but increase both in area and volume. Again, when surrounding a Morula

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxx. pl. xxi. fig. 1, 1878.

these cells are readily distinguishable from all other cellular elements not only by their extraordinary size but also by their containing numerous, and comparatively very large, granules. That a generative product when it—contrary, *e.g.*, to the spermospores of Calcarea—increases during maturation, must receive nutritious material from the surrounding parts of the parent body is indeed obvious, but in the Porifera this may be done in two ways, either by the endothelial cells playing an intermediate part, or, by means of a certain modification, becoming so to speak staples for the material to be consumed by the growing product. The first is the case as regards the sperm-balls, their endothelial cells in all stages of development representing typical pavement-cells, and with further growth gradually becoming rather flatter. Since a sperm-ball, for instance, of *Aplysilla sulphurea* when quite mature is many times larger than the cell from which it derived its origin, it must be assumed that its increase is due not only to the nutritious material within the primitive cell itself, but also to the material absorbed from the surrounding elements. Now the surrounding elements, viz., the endothelial cells, are neither voluminous nor rich in nutritious particles; thus the only possible conclusion is that these endothelial cells having received nutritious material from other cellular elements do not retain it but give it up instantly to the generative product. On the contrary, the endothelial cells surrounding a developing embryo of, *e.g.*, a *Cacospongia scalaris* retain the nutritious particles, and it is in this property that we have also a natural explanation of the striking aggregation of mesodermic cells in the neighbourhood of a developing embryo, as observed and described by F. E. Schulze.[1]

Colour.—Outer surface brownish, parenchyma and skeletal fibres pale greyish.

Habitat.—Station 135A, October 16, 1873, off Tristan da Cunha; depth, 75 fathoms; hard ground, shells, and gravel.

Euspongia, Bronn.

Spongidæ with fine skeletal fibres forming a compact network, the meshes being very small; primary and secondary fibres readily distinguishable.

Euspongia officinalis (Linné), var. *lobosa*, n. var. (Pl. VI. fig. 1).

The single specimen on which this variety is founded recalls by its external shape the drawing which F. E. Schulze[2] gives of *Euspongia officinalis* var. *tubulosa*, with the distinction that its basal part is not plate-like as in the latter, but massive. As in most *Euspongiæ* the outer surface is denticulated owing to the prominent primary fibres, but here the conuli are very low, their height not exceeding 0·3 mm. A portion of the skeleton is represented on Pl. VI. fig. 1; it is bush-like, and it must be noticed that while

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. pl. iii. fig. 1, 1880. [2] *Ibid.*, Bd. xxxii. pl. xxxiv. fig. 8, 1879.

in other *Euspongiæ* the primary fibres run usually more or less parallel to one another, here they show a very pronounced tendency to ramify; the spaces between them and their secondary, but still vertically directed, branches being filled with an irregular network of fibres originating also from the primary ones, but in a more or less horizontal direction. The average basal diameter of the primary fibres is 0·1 mm., that of the tertiary only 0·03 mm. The latter, in contrast to the primary fibres, are in most cases quite free from foreign enclosures. This variety is a connecting link between *Euspongia officinalis* and *Cacospongia mollior*, and may be classed in the species last mentioned with the same right as in *Euspongia officinalis*.

Colour.—Outer surface pale greyish, parenchyma colourless, fibres straw-yellowish.

Habitat.—Bahia, shallow water.

Hippospongia, F. E. Schulze.

Spongidæ with fine skeletal fibres and small meshes, the fibres admitting of no distinction into primary and secondary ones; distinguished by a system of canals permeating the body in all possible directions.

Hippospongia anomala, n. sp. (Pl. VII.; Pl. VI. fig. 2).

This species is represented in the Challenger Collection by a single but very large specimen 350 mm. broad, 200 mm. high, and 40 mm. thick, drawn of the natural size, but in a bent position on Pl. VII. For its characters, common to the whole genus, I refer to the diagnosis in the foregoing paragraph. The character distinguishing it from other species of the genus is a property which renders its grouping in the genus *Hippospongia* rather disputable. I mean the presence of quite distinct primary fibres directed obviously towards the outer surface, on an average four times as thick as the others, and absent only in the skeleton supporting the thin membranes covering the lacunæ immediately under the outer surface. It must be said that the terminal skeletal processes of a *Hippospongia equina*, when seen with the naked eye, show within them certain streaks perpendicular to the outer surface; but these streaks and the fibres in question of my *Hippospongia anomala* are quite different things, the last-mentioned being really nothing but single fibres thicker than the others, the first-mentioned being composed of many fibres and differentiated from the surrounding parts of the skeleton by the fact that the network formed by the fibres is here more compact than elsewhere. The appearance is therefore only an optical illusion; at any rate the property in question distinguishes my species readily from all others of the genus, but does not, however, decide the question whether it really belongs to the genus *Hippospongia*. Still I am of this opinion. As regards the rigidity of the skeleton this specimen is, indeed, allied to *Cacospongia mollior*; but apart from distinctions concerning the presence of the system of canals

permeating its body, the external shape of the animal and particularly its shagreen-like surface, its skeleton (more compact than, but not nearly so hard as, that of *Cacospongia mollior*) recalls that of a *Euspongia* rather than that of a *Cacospongia*.

If now this species, as regards the property of its skeleton, were a typical *Euspongia*, the question as to its systematic place would be still more difficult; one classifier might place it in the *Euspongiæ*, another, and on grounds of equal validity, among the *Hippospongiæ*. Now the species in question is neither a *Euspongia* nor a *Cacospongia*, nor a typical *Hippospongia*; but since one of the main characters of *Hippospongia* is very characteristic of this specimen, the most logical proceeding will be, I think, to group it in this latter genus. For my own part I do not doubt that the species in question, be it referred to *Hippospongia* or *Euspongia*, will still remain a good species, and I shall be quite content if my description prove sufficient for future recognition. In order to render it more complete I add the following details. The average diameter of the primary fibres reaches 0·12 mm., that of the secondary fibres being on an average only 0·028 mm.; the latter are nearly all quite free from any foreign enclosures; the first-mentioned, however, are so full of them that their surface is of a rather angular character, owing to the fact that these foreign bodies lie not only in the central part of the fibres but also in their peripheral portions, projecting outwards and thus rendering the surface of the fibres uneven. It is in this form that I have found, hand in hand with normal flagellated chambers, chambers devoid of any special cameral canaliculis, although in other details its internal organisation presents no deviations from that, for instance, of *Euspongia officinalis*. The specimen proved to be sterile.

Colour.—Soft parts and outer surface pale yellowish-white, skeleton straw-yellow.

Habitat.—Station 186, September 8, 1874, lat. 10° 30′ S., long. 142° 18′ E., depth 8 fathoms, coral mud.

Hippospongia mauritiana (Pl. VI. fig. 3).

Spongia lapidescens, Duchassaing de Fonbressin et Michelotti; subspecies *mauritiana*, Hyatt, Revision, &c., vol. ii. p. 527.

There can be scarcely any doubt that the three specimens of the collection now under consideration are to be referred to Hyatt's *Spongia lapidescens*, subspecies *mauritiana*. His description is very good and detailed, and the form itself, owing to the density of its skeleton, admits of a very clear definition. But what appears to me very strange is that Hyatt still finds it possible to distinguish in its skeleton primary and secondary fibres. I find them all approximately of the same size; of course the bundles of parallel fibres projecting from the outer surface are directed vertically, but seeing that they are not united one with another by smaller horizontal fibres, and that they do not differ in thickness from other fibres of the skeleton, I see absolutely no grounds for regarding

them as primary; and it is owing to this character, as well as to the body being permeated by a regular system of internal canals, that I must[1] place the form in question as a new species in the genus *Hippospongia*, F. E. Schulze.

Colour.—Soft parts yellowish-pale, skeletal fibres dark yellow.

Habitat.—Off Api, New Hebrides, 18th August, 1874; depth 60 to 70 fathoms.

Cacospongia, Oscar Schmidt.

Spongidæ with readily distinguishable primary and secondary skeletal fibres of comparatively thick diameter and forming comparatively large meshes.

Cacospongia levis, n. sp. (Pl. V. figs. 1–3).

The external surface of the single Challenger specimen is quite smooth except in some spots where is is rather roughened by the ascending primary fibres. It is in this property that, bearing in mind the conjectural affinities of the species, I am inclined to see its most important systematic character. The species seems to be closely allied to *Cacospongia mollior*, but as we learn from F. E. Schulze (compare his drawing in the memoir on the Spongidæ), the outer surface of the latter is denticulated throughout. Again, the meshes of *Cacospongia levis* are rather smaller than those of *Cacospongia mollior*, and its primary fibres are 0·08 mm., the secondary ones only 0·04 mm. thick, the corresponding fibres in *Cacospongia mollior* being on an average 0·15 mm. and 0·05 mm. in diameter. Approaching as regards these latter characters to my *Hippospongia anomala*, the species in question differs both from it and from *Euspongia officinalis* var. *lobosa* in a sharply pronounced rigidity of its skeleton. Just as in *Hippospongia anomala*, the body of my *Cacospongia levis* proved also to be perforated by numerous canals, but neither do these canals show, on the whole, any regular arrangement, being quite analogous to those of *Cacospongia cavernosa*, nor is any membrane to be found above their terminal points, so that there can be no doubt as to the systematic position of this sponge. The primary fibres though not prominent may still be readily distinguished (Pl. V. fig. 2). They proved to be cored with foreign bodies, chiefly fragments of spicules lying, however, only in the central part of the fibre; in contrast to this, the secondary fibres are quite devoid of any enclosures. In the soft parts of the specimen in question I found some formations which though lying free in the parenchyma, *i.e.*, not surrounded by a special endothelial layer, nevertheless presented a great resemblance to sperm-balls. A more careful examination and the application of high magnifying powers showed, however, that these formations are scarcely identical with sperm-balls. Their contents consist of numerous oval bodies in which no nucleus could be distinguished, but quite homogeneous throughout

[1] Comp. p. 84.

their whole extent, and, in spite of my endeavours to discover any initial or further stages in their development, I find these oval bodies enclosed, though differing in size but always with precisely the same external appearance. I believe they belong to some low plants.

Colour.—Outer surface black, parenchyma dirty yellowish-grey, skeletal fibres brownish-yellow.

Habitat.—Off Barra Grande, September 10, 1873; depth 400 fathoms, red mud.

Cacospongia amorpha, n. sp. (Pl. VI. fig. 5).

The properties of the skeleton of this species recall those of *Euspongia officinalis*, var. *lobosa*, as regards the tendency of the primary fibres to ramify, but the fibres, both primary and secondary, are comparatively far larger, as are also the meshes formed by them; one might illustrate the difference between these two forms by comparing them to a bush and a tree.

The species is represented by two specimens, one of a massive stout appearance, the other 100 mm. high by about 20 mm. thick, of roundish outline in the upper part, and flatly compressed near the rather extended bases. The outer surface is denticulated by prominent primary fibres forming conuli of 1 mm. on an average, and 3 to 5 mm. distant from one another. In many instances the membrane between the conuli is not homogeneous but sieve-like, the pores being very conspicuous. All the primary fibres are overcharged with foreign bodies, this property rendering them of irregularly angular outline; some of the secondary fibres are devoid of any enclosures, others on the contrary being more or less covered with sand-grains, fragments of spicules, &c., and often a fine secondary fibre shows an extension in its middle, owing to the presence of a sand-grain many times larger than the diameter of the fibre itself. It may also be added that, as in *Hircinia variabilis* according to F. E. Schulze,[1] the primary fibres in my *Cacospongia amorpha* show a tendency to form meshes.

Colour.—Outer surface grey, parenchyma butter-like, skeletal fibres pale brownish-yellow.

Habitat.—Bahia, shallow water.

Cacospongia murrayi (Pl. IV. fig. 3; Pl. VI. fig. 8).

It is really very agreeable, after such a bad species as that just described, to pass on to the description of such a *bona species* as *Cacospongia murrayi*. The single specimen on which this species is founded is represented on Pl. IV. fig. 3, the skin of one part being stripped off. The external surface is smooth throughout, and is represented by a rather thick dermal membrane, which, owing to the great number of foreign

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. pl. iii. fig. 1, 1880.

bodies enclosed, differs obviously both in colour and consistence from the proper parenchyma, and can be easily drawn off. This peculiarity is of course of very doubtful importance. I have very often had occasion to speak of the low systematic significance of similar properties of the skin, and it is sufficient to peruse the lines which F. E. Schulze devotes to the matter in his paper on *Hircinia*[1] in order to become convinced that species based on such characters are very doubtful. The more the dermal membrane is charged with foreign bodies the more easily can it be drawn off, and on the other hand it is obvious that the number of foreign bodies enclosed in the membrane depends on the nature of the surrounding ground.

Of course it cannot be denied that the tendency to form such a cortex of foreign bodies may become hereditary, but still its systematic application appears to me to be rather dangerous; and with respect to my *Cacospongia murrayi*, it is the less necessary as the sponge shows another peculiarity of an undoubtedly more constant character, concerning the structure of the skeleton. In *Cacospongia murrayi* the skeleton is, so to speak, composed of two skeletons. There are vertical primary fibres 0·15 mm. in diameter, and rather finer secondary fibres united to the first-mentioned in a more or less regular horizontal direction, and this system of primary and secondary fibres is enveloped in an irregular network of still finer fibres (0·015 mm. in diameter on an average), originating both from primary and secondary ones, but forming far smaller meshes. Pl. VI. fig. 8, representing the outer surface of a portion of skeleton, when seen against the light, illustrates this peculiarity sufficiently well. The outermost points of the primary fibres are either pretty well developed, and accordingly project from the outer surface into the substance of the cortex, without giving rise, however, to any unevenness on its outer surface, or are very short, and represented only by low thickenings over the intersecting point of the primary and the uppermost secondary fibres. The histological character of the cortex presents no deviations from the usual connective tissue of Keratosa, except that the cellular elements, stellate and fusiform cells, are very scanty; the histological and anatomical structure of the proper parenchyma is that of typical Spongidæ.

The species is named in honour of Mr. John Murray of the Challenger Expedition.

Colour.—Outer surface grey, parenchyma pale greyish, skeletal fibres brownish.

Habitat.—Station 163B, June 3, 1874, off Port Jackson; depth 35 fathoms, hard ground.

Cacospongia vesiculifera, n. sp. (Pl. IV. fig. 2; Pl. VI. fig. 9).

This form, like the one just described, isr epresented in the Challenger Collection by a single specimen, and is in its turn provided with a special cortex, but here its

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. p. 14, 1880.

presence alone justifies the establishment of a new species; this mainly owing to its histological peculiarities. Apart from the foreign enclosures, its constituent parts are scantily developed transparent ground-mass, and in this latter large vesicular cells of round or more oval form, 0·02 mm. in diameter, not dissimilar to the renowned and still debatable "Schleimzellen" of Mollusca, as Dr. Flemming[1] has drawn them, and thoroughly identical with the vesicular cells of many Desmacidonidæ—undescribed indeed hitherto, but undoubtedly very well known to every spongiologist who has had to deal with the representatives of the family just mentioned. A portion of the cortex with such cells is shown in the annexed woodcut.

But the sponge also possesses some other characters which render it readily distinguishable from other Keratosa, its skeleton recalling that of a *Spongelia* rather than that of *Cacospongia*, and its external shape being perhaps also of some systematic value. The sponge has been found in the form of a thick-walled tube, with very narrow central cavity, ending in a small osculum. The outer surface is rough and provided with rounded tubercles corresponding to the prominent secondary fibres. There are in this sponge three kinds of skeletal fibres—(1) gastric vertically directed primary fibres, in most cases more or less loaded with foreign bodies, and on an average 0·2 mm. thick; (2) centrifugal secondary fibres, originating from the primary ones, and in their direction towards the outer surface forming with the last mentioned, if from above, a more or less acute angle, and with an average diameter of 0·1 mm.; and (3) still finer (0·06 mm.) tertiary fibres uniting the secondary and primary ones; to sum up, this is a kind of skeleton very common in Spongelidæ, but exceptionally rare in Spongidæ. The secondary and tertiary skeletal fibres proved to be free from any enclosures. Apart from the vesicular cells there are no other histologically or anatomically deviating peculiarities to be stated.

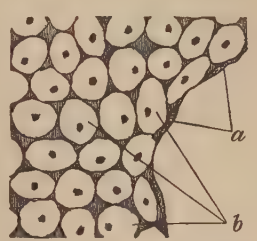


Fig. 2.—Cortex of *Cacospongia vesiculifera*. *a*, pavement epithelium of a subdermal cavity; *b*, vesicular cells.

Colour.—Outer surface dirty greyish, parenchyma pale yellowish-white, skeletal fibres straw-yellow.

Habitat.—Off Port Jackson, April 1874; depth 7 fathoms.

Cacospongia procumbens, n. sp. (Pl. VI. fig. 6).

This species—a *Sarcotragus* in the sense of Oscar Schmidt—possesses a very curious skeleton. In *Cacospongia vesiculifera* we have had to deal not only with primary and secondary, but also with tertiary skeletal fibres; here there are not even primary and secondary ones. The sponge has been found in the form of a crust, and its supporting

[1] Die Bindesubstanz der Mollusken, pl. i.

apparatus is represented by a large meshed thoroughly irregular basal network of the skeletal fibres, with numerous ascending branches directed towards the outer surface, with a denticulated appearance due to conuli, about 0·75 mm. high and 3 to 4 mm. distant from one another. All the fibres are approximately of the same thickness (0·18 mm. on an average), and all cored in their central part, very scantily, however, with foreign bodies. As before remarked, the species would be referred by O. Schmidt to his subgenus *Sarcotragus*, the filaments filling its parenchyma being very thin and fine.

In the skin are numerous fragments of siliceous spicules.

Colour.—Parenchyma pale brownish, skeletal fibres deep brown.

Habitat.—H.M.S. "Porcupine," Station 13, 1870, off the coast of Portugal; depth 220 fathoms.

Cacospongia dendroides, n. sp. (Pl. VIII. figs. 1–3; Pl. VI. fig. 14).

There are in the Challenger collection three specimens, all of a rather Spongeloid shape, and from the same locality, but presenting some distinctions in the structure of their skeleton, so that a subdivision at least into varieties is necessary. One of the specimens is represented on Pl. VIII. fig. 1, and therefore a further description of its general form is superfluous. The other specimens all agree as to their external shape with the one just mentioned, but while the skeleton of this latter (Pl. VI. fig. 14) is composed of an irregular network of comparatively thick and yellow coloured fibres, the skeletons of the two other specimens, which do not differ from the former as to the general character of the network, are composed of fibres twice as thin, forming meshes approximately twice as large as in the former case, and not of a yellow colour but white. Is this a character of individual or of varietal, or of specific significance? I must confess I am not prepared to decide the question, and think it advisable to choose the middle course by establishing two provisional varieties—*dura* for the specimen with more solid fibres, and *friabilis* for the two remaining. In both cases all the skeletal fibres proved to be more or less cored with foreign enclosures. All the three specimens have proved to be full of filaments, and it was in two of them that I found out those dumb-bell-shaped corpuscles to which I have referred on page 14.

If amongst the skeletal fibres of this form the primary—vertically directed—can be still distinguished owing to their comparative thickness, it must yet be added that such a distinction is of a rather conditional character, the skeleton presenting the aspect of a pretty irregular network.

Colour.—Pale yellowish-white.

Habitat.—Station 208, January 17, 1875, lat. 11° 37′ N., long. 123° 31′ E.; depth 18 fathoms, blue mud.

Cacospongia spinifera, n. sp. (Pl. VI. fig. 12).

Had the genus *Oligoceras* been retained it would have been necessary to refer the species I am going to describe to that genus. The outer surface of the single specimen representing this new species in the collection is indeed a contrast to *Oligoceras collectrix*, being quite devoid of any foreign bodies, but they are abundant in the parenchyma, and on the other hand are so richly represented in the skeletal fibres that these latter are extremely poor in true horny substance. Again as to the external aspect of its skeleton,—apart from the point that it is not represented by isolated standing trees as in *Oligoceras collectrix*,—it recalls vividly that of the form just mentioned. The large size of the meshes, the tendency of the fibres to ramify—all this approximates the form I am now describing to *Cacospongia* (*Oligoceras*) *collectrix*. There is, however, a character which permits a pretty sharp diagnosis of the species; I mean the nature of its outer surface. The latter, in spite of the great friability of the skeleton and its general tendency to disappear entirely, is still provided with very high conuli (4 to 7 mm.), so that, if drawn, this specimen would give precisely the same impression as the drawing given by Hyatt for his *Hircinia acuta*,[1] and this not only with regard to the character of the outer surface, but also that of the external shape of the sponge in general. The specimen must have died at the moment when its dermal pores were open, and thus the whole of its outer surface is of a sieve-like appearance in the proper sense of the word. Apart from the point that, like the preceding form, this specimen proved to be overloaded with filaments, their heads being of elongated form and reaching 0·06 mm. in length and 0·04 mm. in breadth on an average, there are no histological nor anatomical peculiarities of interest to be stated.

Colour.—Outer surface brownish-grey, parenchyma pale greyish, skeletal fibres black.

Habitat.—Station 177, August 18, 1874, lat. 16° 45′ S., long. 168° 7′ E.; depth 130 fathoms, volcanic sand.

Cacospongia tuberculata, n. sp.

So far as the properties of the skeleton are concerned (apart from the fact that the fibres are not black but pale yellow), this species seems to be closely allied to *Cacospongia spinifera*. Indeed, in most cases the primary fibres do not ramify at all, but ascend vertically, and are united with one another by horizontal secondary fibres, these latter, as in *Cacospongia spinifera*, beginning very often with flat extensions; yet, here and there ramifying fibres have been found, their secondary obliquely directed branches instead of reaching the neighbouring primary fibres ending freely. There is, however, one character

[1] Revision, &c., vol. ii. pl. xv. fig. 20.

in the two specimens by which the species is represented, admitting probably of a tolerably good distinction of the form in question from *Cacospongia spinifera*. It is the appearance of the outer surface, which is here not spinous but provided with rounded tubercles. How far this peculiarity permits the establishment of a new species is difficult to say; at any rate I see at the present time no other course open but to separate the form in question by the establishment of a new species.

Both the specimens proved to be full of filaments, here, however, with heads of a rather different shape from that of the filament-heads in my *Cacospongia spinifera*, being of a more roundish outline, and with an average diameter of 0·055 mm. One of the specimens proved to be quite compact, the other, as in *Cacospongia cavernosa*, was pierced by numerous large internal channels inhabited by Chætopoda.

Colour.—Outer surface greyish, parenchyma white, skeletal fibres pale yellow.

Habitat.—Station 162, April 2, 1874, off East Moncœur Island, Bass Strait; depth 38 fathoms, sand and shells.

Cacospongia intermedia, n. sp. (Pl. VI. fig. 7).

I have already taken occasion to mention (p. 27) this species as presenting to the classifier many difficulties. The meshes formed by its skeletal fibres being rather large, and the fibres themselves thick, the form must be referred to *Cacospongia;* but the fibres are almost all of the same diameter (0·35 mm.), and it is only in the prominences of the outer part of the skeleton that an approximate distinction between primary and secondary fibres is possible. This character recalls the *Coscinoderma* of Carter; on the other hand, the body of the sponge is broken through by numerous canals, the character of the outer surface of the skeleton is that of *Hippospongia*, the distinction between primary and secondary fibres, as already stated, is pronounced only in the tufts; all this would justify the placing of this sponge in the genus *Hippospongia*, provided that one could prove the importance of the characters just mentioned to be greater than that of the skeletal fibres being thick and the meshes formed by them large. So far as to the general position of the form in question. Now it must be mentioned that apart from the thickness of the skeletal fibres and the largeness of their meshes, the sponge recalls vividly *Euspongia vermiculata*. What systematic place is to be assigned to it? Of course merely a provisional one, and accordingly the task of the classifier is reduced to giving a detailed description of it.

The species is represented in the collection by a single specimen of irregularly massive form; the outer surface is smooth and even, the dermal membrane enveloping the skeleton with its external outgrowths in the same manner as in *Hippospongia anomala*. In many spots the dermal membrane is pierced by larger or smaller (2 to 4 mm.) openings, sometimes disposed by threes or fours together, sometimes lying isolated; whether some of these openings are really oscula is difficult to say without a complete destruction of

the specimen; but this is certain, that most of them are "pseudo-stomata," leading into the canals separating the body of the sponge, and the envelope of whose walls is merely the continued dermal membrane. The properties of the skeleton have been already discussed, and I hope that with the help of the figure given on Pl. VI. its characters will be rendered obvious; its outer surface recalls that of *Hippospongia mauritiana* (Pl. VI. fig. 3), apart from an entire absence of bundles of parallel fibres.

Colour.—Outer surface black, parenchyma greyish, skeletal fibres brown.

Habitat.—Station 177, off Api, New Hebrides, August 18, 1874; depth 130 fathoms, volcanic mud.

Cacospongia irregularis, n. sp. (Pl. VI. fig. 10; Pl. VIII. fig. 5).

The chief peculiarity of this curious species consists in this property of its skeleton, that, in contrast to all other Spongidæ, the bundles of its fibres are so closely and irregularly intertwined that the distinction of primary and secondary ones is entirely impossible; they form a kind of irregular network, its meshes being not represented by internal channels as in *Hippospongia*, but filled by parenchyma. The species is represented in the collection by a single specimen, apparently of irregularly massive form, in reality provided with large internal cavities, so that the sponge can be compared to a casket. The surface is smooth, but not devoid here and there of outgrowths corresponding to the prominent tufts of skeletal fibres, presenting a compact network, and in most cases ending more or less sharply. As to the secondary meshes of the skeleton, they are quite irregular, and my drawing (Pl. VI. fig. 10) will give a better explanation of them than any words. The primary meshes, *i.e.*, meshes formed by the skeletal fibres themselves, are in most cases small, but in others very large, and occasionally a mesh is represented by two bundles forming an acute or obtuse angle and a single usually thick fibre. The thickness and length of the fibres are very variable, but all agree with one another as to their tendency to take in foreign bodies. The specimen proved to be overcharged with filaments, one of which is represented on Pl. VIII. fig. 5.

Colour.—Outer surface and parenchyma pale dirty yellowish, skeletal fibres pale grey-yellowish.

Habitat.—Station 188, September 10, 1874, lat. 9° 59′ S., long. 139° 42′ E.; depth 28 fathoms, green mud.

Cacospongia oligoceras, n. sp. (Pl. VI. fig. 13).

This species is represented only by a small fragment of massive shape, with the outer surface, where not covered with mussel-shells, stones, &c., provided with low conuli. Its exterior agrees closely with that of *Oligoceras collectrix*, Schulze, but there is a great

difference with regard to the structure of the skeleton; in *Oligoceras collectrix* the skeleton is represented by small isolated horny trees, and there are parts in the body where no skeleton is to be found at all; in the species I am describing it is present everywhere, but though a continuous network, is very often interrupted by large, enclosed, foreign bodies. The skeletal fibres are full of fragments of spicules, sand-grains, &c.; their form, whether cylindrical or flat, as well as the size of the meshes formed by them, is very variable. A portion of the skeleton (×2) is represented on Pl. VI. fig. 13. The thickness of its fibres, vertical and horizontal indiscriminately, varies from 0·06 to 1 mm.

Colour.—Outer surface greyish, parenchyma butter-yellowish, skeletal fibres white.

Habitat.—Station 208, January 17, 1875, lat. 11° 37′ N., long. 123° 31′ E.; depth 18 fathoms, blue mud.

Cacospongia compacta, n. sp. (Pl. VI. fig. 11).

The external shape of the single specimen representing this species in the Challenger collection recalls that of *Euspongia officinalis*, var. *lobosa*, but of course this coincidence is of no further consequence, the form in question showing the closest affinities to *Cacospongia oligoceras* just described. There are, however, the following distinctions: the meshes in the former are comparatively large; in the latter they are so very narrow that the whole skeleton at first sight appears to be a compact mass (comp. Pl. VI. fig. 11); in both cases the horny substance is scantily developed, the chief foundation of the skeletal fibres being represented by foreign enclosures, but while the fibres of *Cacospongia oligoceras* and its whole skeleton are friable, those of *Cacospongia compacta* are rigid and hard. Again, when a fibre of the former is seen under the microscope, it gives the impression that the taking in of foreign bodies has been influenced by the kind of growth of the fibre; they are disposed in it as if following certain laws of distribution, and although overloaded with them, the fibres still possess a rather smooth surface. It is a strained expression to speak of differentiated skeletal fibres with regard to *Cacospongia compacta;* a portion of its skeleton when magnified conveys the impression as if there were previously some sand-grains disposed in the parenchyma without any order, and these sand-grains were latterly enveloped in a continuous mass of horny substance. Here a large sand-grain, and immediately as a continuation of this thickening a short piece of a typical horny fibre without any enclosures, finishing again with a new similar thickening.

We are hitherto in complete uncertainty as to the systematic value of the colour of the horny substance in these and other cases. But if it be of consequence, this character alone would justify the separation of both the forms compared; in *Cacospongia oligoceras* it is colourless, while in the species I am characterising it is of an intense yellow colour.

The specimen proved to contain filaments, not being, however, particularly rich in them.

Colour.—Soft parts dirty white, skeletal-fibres brownish-yellow.

Habitat.—Bahia; shallow water.

Cacospongia collectrix, F. E. Schulze, sp.

Oligoceras collectrix, F. E. Schulze, Zeitschr. f. wiss. Zool., vol. xxxiii. p. 34.

The two Challenger specimens which I group in this species are so different in external shape that, should we classify the Keratosa according to their form, we should be obliged to refer them, at least, to different genera. Yet it is well known that in most cases the external shape as well as the colour in the Porifera are of extremely subordinate consequence, and I am the more inclined to regard both the specimens in question only as individuals of the same species, as in the Dalmatian specimen of *Cacospongia collectrix* described by F. E. Schulze we find a form of, so to speak, neutral characters with respect to the differences above mentioned. These differences concern the mode of growth and the quantity of foreign bodies enclosed in the parenchyma. The Dalmatian specimen just alluded to is represented in Prof. Schulze's paper on pl. ii. fig. 6, and one can see that is not crust-like but of massive shape. On pl. iii. fig. 7, Prof. Schulze gives also a drawing of the anatomical organisation of the specimen in question, and this drawing renders obvious that, contrary to the specific designation of *collectrix*, its soft parts are comparatively free from foreign enclosures. This latter character is common to the Challenger specimen of *Cacospongia collectrix* from the Philippine Islands, while as to its external shape this specimen has been found in the form of a crust. On the contrary, the second Challenger specimen (from Japan) recalls vividly, so far as its exterior is concerned, F. E. Schulze's specimen from Lesina, but its soft parts proved to be overloaded with foreign enclosures, almost exclusively sand grains often 2 to 3 mm. in diameter. It is therefore plain that the above differences may be important enough to justify the subdivision of the species into independent varieties, but in no case of a greater consequence. All this, however, on the supposition that *both* our specimens are really closely allied to *Cacospongia collectrix*, F. E. Schulze. So far as the specimen from the Philippine Islands is concerned this is beyond doubt. This specimen, together with the mussel-shells which it coats, is also of a rather lumpy, massive form; a more attentive examination shows, however, that this is due simply to the aggregation of the mussel-shells, and that the sponge itself is of a well-marked crust-like appearance, sometimes as thin as a leaf of paper. Now, while in some parts of it no skeleton is to be discovered at all, the others are propped by small (2 to 7 mm. high and about 0·5 mm. thick), isolated horny trees very rich in enclosed

foreign bodies—all precisely as in the original specimen of the form from Lesina; and as its internal organisation also does not deviate from that of *Cacospongia collectrix* as described by F. E. Schulze, there is no room to doubt the specific identity of both these specimens. But the matter is quite different with regard to the Challenger specimen from Japan. Its internal structure also does not differ from that of a typical *Euspongia* or *Cacospongia*, but—and this is the salient point—I was unable to make out whether this specimen really does possess any differentiated horny skeleton. This was owing to its minuteness, its dimensions being on an average as follows:—length 22 mm., height 7 mm., breadth 10 mm. The half of the specimen has been sacrificed to the decision of the above question; the result of a lasting treatment with hot water and ammonia was a heap of sand-grains and a single 2 mm. high horny tree also very rich in foreign enclosures. Is it to be regarded as produced by the sponge itself? Is it also nothing but a foreign enclosure, like what Marshall states[1] of the specimens of *Psammopemma densum* he had for examination? All this remains an open question. That our specimen is a horny sponge is quite plain, the foreign bodies enclosed in its parenchyma being undoubtedly surrounded with obvious horny substance; that, being a Keratose sponge, it is also a Spongid is demonstrated by its internal structure, but whether it is to be classed in the species *Cacospongia collectrix*, and not to be regarded as an analogue of *Psammopemma* in the family of Spongidæ, will be decided but by later investigations. Of course under such circumstances I prefer to abstain from the creation of a new name.

Both the specimens proved to contain filaments, but while the specimen from Japan is strikingly poor in them, the specimen from the Philippine Islands on the contrary is overloaded with them in not a less degree than the Challenger specimens of *Stelospongos longispinus* or *Cacospongia irregularis*.

Colour.—Specimen from Philippine Islands, pale greyish-yellow. Specimen from Japan, outer surface grey, parenchyma dirty yellowish.

Habitat.—Station 203, October 31, 1874, lat. 11° 6′ N., long. 123° 9′ E.; depth, 12 to 20 fathoms; mud. Station 233A, May 19, 1875, lat. 34° 38′ N., long. 135° 1′ E.; depth, 8 to 50 fathoms; sand.

Stelospongos, O. Schmidt.

Spongidæ with comparatively thick skeletal fibres united in separated columns directed more or less regularly radially from the basis of the sponge towards the outer surface, and consisting each of a compact network of vertical, primary, and horizontal secondary fibres.

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxv. p. 114.

Stelospongos longispinus, Fonbressin et Michelotti, sp. (Pl. VI. fig. 15; Pl. VIII. fig. 4).

Polytherses longispina, Fonbressin et Michelotti, Spongiaires de la mer Caraïbe, p. 71.
Hircinia acuta, var. *longispina*, Hyatt, Revision, &c., vol. ii. p. 549.

The descriptions of Fonbressin and Michelotti and Hyatt agree closely with the properties of one specimen of the Challenger collection, and I have no doubt that I am right in identifying it with *Hircinia acuta*, var. *longispina* of Hyatt. How far the other varieties of this species distinguished by Hyatt are really to be referred to the genus *Stelospongos*, I am not prepared to say, but it is obvious that the conjectural variety we are speaking of is a true *Stelospongos*. Hyatt himself says, "In fact, so strong is the resemblance (between a *Stelospongos* and the form in question) that it was at first classified with that genus," but constant to his dermal-membrane theory of the formation of the skeleton, he assigned to the form another systematic position. Now we know that the theory just cited is false, and a different procedure is necessary. Indeed, when compared with *Stelospongos maynardii*, or any other true *Stelospongos*, our specimen is not a typical representative of the genus. It is but seldom that one can distinguish in the columns constituting the skeleton—some of which are represented on Pl. VI. fig. 15—the vertical primary, and more or less horizontal secondary, fibres, but in some instances this distinction is still evident, and accordingly there can be scarcely any objections to the proceeding adopted here.

The specimen proved to be full of sperm-balls, and in a far greater degree of filaments, one of which is represented on Pl. VIII. fig. 4.

Colour.—Outer surface dark grey, parenchyma dirty white, skeletal-fibres pale yellow.

Habitat.—Off Barra Grande, September 10, 1873; depth, 400 fathoms; red mud.

Carteriospongia, Hyatt.

Spongidæ of flabellate, leaf-like, or funnel-shaped form, with skeletal-fibres admitting of a distinction into larger primary and smaller secondary ones, with flagellated chambers usually devoid of any inhalent and exhalent canaliculi, with ribbed outer surface.

Carteriospongia radiata, Hyatt (Pl. IV. fig. 5; Pl. V. figs. 7, 8, 9).

Carteriospongia radiata, Hyatt, Revision, &c., vol. ii. p. 541.

There are in the Challenger collection four specimens of the genus *Carteriospongia*, three funnel-like, the fourth presenting a colony of leaf-like individuals, which with regard to the properties of their skeleton—except that the "veil" of Hyatt proved to be propped up not by a network of skeletal fibres but by foreign enclosures—and to those of the outer

surface agree so closely with Hyatt's *Carteriospongia radiata*, var. *dulsiana*, that I have but to refer the reader to the description above mentioned, and wish only to elucidate the anatomical and histological characters of the internal organisation of this interesting species. So far as these latter are concerned, some details have been already given (pp. 17, 18), and it now remains to expose them coherently. Through the pores, inconspicuous to the naked eye and scattered on both surfaces of the animal, the water reaches, as usual, more or less developed subdermal cavities; but these latter, instead of ramifying by forming smaller and more numerous canals (as is the case in *Aplysina* and to a certain degree also in *Euspongia* and other allied genera), in most cases communicate immediately with the flagellated chambers; the dendroid character of these ramifications is here quite lost. The flagellated chambers (all larger than those of true Spongidæ, but still of hemispherical shape) having received the water by means of numerous pores in their walls, expel it, not by means of special canaliculi as is the case in the true Spongidæ, but through a large opening like that in the flagellated chambers of Spongelidæ. The water having left the flagellated chambers enters large exhalent lacunæ of variable outline, and many of these latter uniting together throw it out through the oscula—in the Challenger specimens all on the *internal* surface; in some funnel-shaped specimens in the British Museum, on the contrary, all on the *external* surface. It is an interesting fact that when the sponges are of a leaf-like form, the exhalent orifices are always more or less concentrated on one surface only. In *Ianthella* they are indeed to be found on both surfaces, but still their distribution is not equal—they are numerous on one surface, but very scanty on the other. The properties of the internal organisation are thus rather deviating from those of typical Spongidæ; again, as to the histological structure of the form in question, it differs also from that of true Spongidæ, its ground-mass being almost entirely devoid of granules in the neighbourhood of the flagellated chambers. To the conjectural systematic significance of these differences many pages have already been devoted; we have nevertheless come to the conclusion that at last, provisionally, the genus must be still grouped in the family Spongidæ, owing to the presence of those enigmatic "Stränge" of cells which have been recently described by F. E. Schulze, and which, in spite of a remark of this naturalist as to their entire absence in some individuals of *Euspongia* or *Cacospongia*, I am yet inclined to regard as very characteristic of the whole family. In *all* the Spongidæ I have had the opportunity of examining I found them, and if absent in one region of the body they are still to be found in other parts of it.

One of the specimens examined proved to be full of sperm-balls, one of which in a ripe state is represented on Pl. V. fig. 9. I was able to discern also the preceding stages of their development, but I abstain from their description here, since I shall return to the matter when describing the spermospores of *Verongia*.

Colour.—Pale dirty yellowish.

Habitat.—Off Wednesday Island, Cape York, September 8, 1874; shallow water.

Carteriospongia otahitica, Esper, sp. (Pl. IV. fig. 4).

Spongia otahitica, Esper, Pflanzenthiere, Bd. ii. p. 270.
Carteriospongia otahitica, Hyatt, Revision, &c., vol. ii. p. 541.

This species, represented in the collection by numerous specimens from Admiralty Islands, was established in the year 1794, and there are in spongiological literature many descriptions of it. Accordingly, I consider it unnecessary to enter here into particulars, and refer the reader to the best of these descriptions, that of Hyatt, in the hope that with the help of my drawing on Pl. IV. the characters of the species may be easily comprehended.

Colour.—Dirty pale yellowish.

Habitat.—Off Wild Island, Admiralty Islands; reefs; March 1875.

Family Aplysinidæ, Vosmaer.

Aplysinæ (e.p.), Hyatt.
Ceratina (e.p.), Carter.
Aplysinidæ (e.p.), F. E. Schulze, v. Lendenfeld.

Keratosa with small either hemispherical or pear-shaped flagellated chambers communicating with exhalent and inhalent cavities, each by means of one comparatively long and narrow inhalent and exhalent canaliculus. Axis of fibres thick; ground-mass in the neighbourhood of the flagellated chambers overloaded with granules.

Luffaria, O. Schmidt.

Aplysinidæ with thick-walled heterogeneous skeletal fibres, their central part but little differentiated optically from the surrounding horny lamina.

Luffaria variabilis, n. sp. (Pl. IX. figs. 1–6).

As I remarked before (p. 33), I am not prepared to say whether all *Luffariæ* in addition to thick skeletal fibres also possess fine ones. But should such be the case, the species I am going to describe may still be readily distinguished from all others of the genus by the following peculiarities; its skeletal fibres are not at all so glass-like and fissile as Schmidt states with regard to the specimens he had for examination. Again, though on the whole its skeleton admits of comparison with a burst but still only with a very imperfect one, the distance between the prominent outer fibres reaching 1 to 2 mm. In addition to some small fragments, the species is represented in the Challenger collection by two specimens, one of massive shape, the other on the contrary

in the form of three elongated stalks connected together at their bases. I do not think that this difference in external appearance can justify the establishment of two varieties; for in the structure of their soft parts (quite identical with that of *Aplysina*), and again in that of the skeleton, the specimens do not differ at all. Indeed the colour of the parenchyma in one case (massive specimen) is rather yellow, in the other greyish, but I am not inclined to ascribe any consequence to this difference. Both the specimens are represented on Pl. IX. I have nothing further to add to this illustration, and as to the properties of their skeleton in general and to those of their skeletal fibres I refer the reader to page 7 of this report.

Colour.—Outer surface greyish, parenchyma yellow and dirty greyish-white, skeletal fibres brownish-yellow and brownish.

Habitat.—Station 177, August 18, 1874, off Api, New Hebrides; depth 60 to 70 fathoms. Off Tahiti; reefs; September 1875.

Verongia, Bowerbank.

Aplysinidæ, the central axis of whose thick-walled skeletal fibres is readily to be distinguished optically from the surrounding horny walls.

Verongia hirsuta (?), Hyatt (Pl. X. figs. 1–3).

Verongia hirsuta, Hyatt, Revision, &c., vol. i. p. 403.

I leave to later investigators the decision of the question whether the form I am going to describe is identical with *Verongia hirsuta*, var. *fistularoides* of Hyatt. His description is very short, and there are no explanatory illustrations; it agrees, however, closely with what I can give of the form in question. I myself indeed should call the meshes of the skeleton regular, but with regard to this difference the utmost caution is advisable. In *Verongia fistularis* (*Spongia fistularis*, Linné) from the Museum of Erlangen, which both Hyatt and myself were able to obtain for the purpose of comparison, and which is placed by Hyatt in his family Dendrospongiadæ, characterised *inter alia* by irregularity of the meshes, I was able to discern meshes of a geometrically regular polygonal character, and again meshes sometimes of irregularly round, sometimes of irregularly oval, shape.

As to the anatomy of the form, I am glad to confirm the supposition of Vosmaer[1], that it does not differ from that of *Aplysina*; the exposition of the canal-system on Pl. X. fig. 7 has been made after a preparation of *Verongia tenuissima*, but it may be applied also to *Verongia hirsuta*, the more so as both the specimens of *Verongia hirsuta* and *Verongia tenuissima*, represented in the collection each only by a single

[1] On *Velinea gracilis*, p. 444.

specimen, proved to be full of spermospores. To a more detailed description of these latter I shall return later, and will now merely call attention to this peculiarity of the skeletal fibres of my *Verongia hirsuta*, that they almost all proved to be covered with small plates of polygonal outline as represented on Pl. X. fig. 3; I have been unable to make out their origin. Occasionally, and particularly on young fibres, I found no such plates, but small drops of yellow substance at a comparatively great distance from one another. I can but state, and this with the greatest certainty, that these plates are not modified spongoblasts. I regard them as the last product of the spongoblasts, ready to lose their spongoblastic properties in order to become common stellated cells.

Colour.—Pale rose-brownish, skeletal fibres dark brown.

Habitat.—Off Bermudas, June 1873; reefs.

Verongia tenuissima, Hyatt (Pl. X. figs. 4–7).

Verongia tenuissima, Hyatt, Revision, &c., vol. i. p. 403.

Hyatt's work upon the Keratosa is so very poor in explanatory illustrations that although the short diagnosis he gives to his *Verongia tenuissima* is entirely applicable to the form I am going to describe, I do not feel quite certain whether both these forms are identical, but if not, at any rate they are very closely allied to one another, and to be probably distinguished merely as different varieties of the same species.

The form is represented by a single specimen. It is of fistular shape, the central cavity being funnel-like, with a circular upper extension of 22 mm., and the walls 20 mm. thick in the basal and middle parts of the body, growing rather thinner towards its upper end. The inner surface, in contrast to that of *Verongia hirsuta*, is smooth but undulating, while the outer surface is hilly; the surface both of hillocks and depressions being shagreen-like, and studded with projecting points of the skeletal fibres. These latter—in thorough harmony with Hyatt's statement on the point—are far thinner and more elastic than those of *Verongia fistularis*, yet at least one and a half times as thick as the fibres of *Aplysina aërophoba;* their average diameter is 0·2 mm., and the meshes formed by them recall vividly in size and shape those of *Aplysina*. The internal organisation, both anatomical and histological, agrees so closely with that of *Aplysina aërophoba* that having illustrated it by a small drawing (Pl. X. fig. 7), I can refer the reader to F. E. Schulze's paper on the Aplysinidæ. I must add, however, that I was not able to discern the bundles of fibrils which he describes[1] and represents on pl. xxii. fig. 14. of his paper. But I was fortunate enough to discover the male generative product, the spermospores; and this both in *Verongia hirsuta* and *Verongia tenuissima*, in this latter form together with ova, scantily scattered in the peripheral parts of the body, while the spermospores have been found everywhere and in abundance. I call them

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxx. p. 397.

spermospores and not sperm-balls, as I did in the description of *Carteriospongia radiata*, for they are quite different in appearance and structure. In *Carteriospongia radiata*, and in other instances, these formations present an aggregation of cells, if not ripe spermatozoa, these cells being each equivalent to the other, and the whole lying in a capsule formed by numerous pavement cells; in *Verongia* the analogous capsule is formed by a *single* cell, the endothelium is not to be found at all. In one word, the male generative products are quite equivalent to those of Calcarea as I have described them in *Sycon raphanus*.[1] I must confess I can find no explanation of this; the matter appeared to me strange even before, when I thought the Calcarea were opposed in this respect to the *whole* group of Silicea. I was thoroughly startled when, hand in hand with indubitable sperm-balls in *Carteriospongia* as well as in some other Keratosa of the collection, I discerned in my preparations of both species of *Verongia* the most typical spermospores. I was not able to follow out their development, but when ripe they recall so vividly the corresponding formations in *Sycon raphanus* (with the sole distinction that while in this latter instance the nucleus of the covering cell in quite ripe spermospores is in most cases indistinct, in *Verongia* I find quite empty capsules, nevertheless, provided with it) that I *must* identify both these formations; on the other hand, I have now no doubt that at the development of the *sperm-balls* no covering cell is formed, that its description by F. E. Schulze[2] agrees closely with the reality. I have repeatedly examined *Oscarella* (*Halisarca*) and *Aplysilla*, and was able to follow out the development of their sperm-balls from the first beginning, and I can only affirm the former statements of F. E. Schulze, that we have in these instances to do with real division of the sperm cells, and that there is no covering cell to be discerned. On the whole the enigmatic question requires a special and extensive investigation, the more so that it is not only of spongiological but also of general interest.

Colour.—External surface black, that of the central cavity and parenchyma grey, skeletal fibres brownish yellow.

Habitat.—Off Barra Grande, September 10, 1874; depth, 400 fathoms.

A perusal of the preceding pages shows that of thirty-four determinable forms brought home by the Challenger Expedition, almost two-thirds (21) have been found to be new, and that only three species (*Psammopemma densum*, *Luffaria variabilis*, and *Cacospongia collectrix*) were obtained from more than one locality. Under such conditions any discussion of the geographical distribution of the Keratosa would be possible only if extended over all the Keratosa hitherto described. It must be said, however, that on

[1] *Sitzungsb. Akad. d. Wiss. Wien*, Bd. lxxxvi., 1882.

[2] *Zeitschr. f. wiss. Zool.*, Bd. xxviii. p. 24, pl. iii. fig. 19.

the whole, our knowledge of the group is in this direction so very fragmentary that even in this case the possibility of any deductions and generalisations is entirely excluded. The annexed Table has, accordingly, no other object than to render conspicuous the comparative richness in Keratosa of the different localities visited by the Challenger, as well as the depths from which they have been obtained. The depth (in fathoms) is indicated by the figures in the columns, s.w. = shallow water.

BATHYMETRICAL TABLE.

	Portugal.	Bermudas.	Nova Scotia.	Brazil.		Tristan da Cunha.	Eastern Coast of Australia.			New Hebrides.	Wednesday Island.	Admiralty Islands.	Philippine Islands.	Japan.	Honoruru.	Tahiti.
				Barra Grande.	Bahia.		Bass Strait.	Port Jackson.	Torres Straits.							
Ianthella flabelliformis, Pallas,									28							
Spongelia spinifera, F. E. Schulze,								7								
,, *pallescens*, O. Schmidt,					s.w.											
,, *horrida*, Selenka,									8							
Psammoclema ramosum, Marsh.,							38–40									
,, *vosmaeri*, n. sp.,									8							
,, *foliaceum*, n. sp.,							38–48									
Psammopemma densum, Marsh.,			83					7								
,, *porosum*, n. sp.,					s.w.											
Coscinoderma confragosum, n. sp.,	220															
,, *denticulatum*, n. sp.,															s.w.	
,, *altum*, n. sp.,						60										
Euspongia officinalis, Linn., var. *lobosa*, n. var.,					s.w.											
Hippospongia anomala, n. sp.,									8							
,, *mauritiana*, Hyatt,										60–70						
Cacospongia levis, n. sp.,				400												
,, *amorpha*, n. sp.,					s.w.											
,, *murrayi*, n. sp.,								30–35								
,, *vesiculifera*, n. sp.,								7								
,, *procumbens*, n. sp.,	220															
,, *dendroides*, n. sp.,													18			
,, *spinifera*, n. sp.,										60–70						
,, *tuberculata*, n. sp.,							38–40									
,, *intermedia*, n. sp.,										60–70						
,, *irregularis*, n. sp.,									28							
,, *oligoceras*, n. sp.,													18			
,, *compacta*, n. sp.,					s.w.											
,, *collectrix*, F. E. Schulze,													12–20	8		
Stelospongos longispinus, Duch. and Mich.,				400												
Carteriospongia otahitica, Esper,												s.w.				
,, *radiata*, Hyatt,											s.w.					
Luffaria variabilis, n. sp.,										60–70						s.w.
Verongia hirsuta, Hyatt,		s.w.														
,, *tenuissima*, Hyatt,				400												

IV.—CONCLUDING REMARKS.

With the last lines of the foregoing chapter the direct and immediate task of this memoir is accomplished, but it remains still to summarise its more general deductions with respect to what I regard as its chief purpose. The tendency of this is to clear up the present state of our knowledge, and in the first place to prove that, in spite of the acquirement of many new systematically important characters introduced into descriptive Spongiology by F. E. Schulze, which concern the peculiarities of the internal organisation of the soft parts, all the arrangements of the Keratosa hitherto proposed are, on the whole, far from being natural. I hope I have made it clear that the procedure of subdividing the group either directly into families or preliminarily into suborders may be adopted merely as a measure of provisional character. I hope I have also proved that the genera established in the Keratosa are not homogeneous, the characters distinguishing one part of them being of an absolute, those distinguishing another part of an extremely conditional, and often very ambiguous, nature. I am, finally, far from any illusions, and feel certain that the perusal of the descriptive part of this memoir, as well as of other systematic papers on the Keratosa, must show plainly that in most cases the classifier has to found his species on characters whose stability is quite unknown to him, so that whether they are really of specific importance or fit only for distinction of individuals, remains open to discussion. The reader sees that the state of matters is far from satisfactory; and it is natural to ask whether it admits at least of some conjectures as to the way in which our knowledge of the Keratosa may become more perfect? I believe this question may be answered in the affirmative; but since, in cases where decisive, incontestable proofs are wanting, the probability of the suggestion depends on the number of arguments, I should like, before I pass on to the recapitulation of the grounds favourable to my opinion, to increase their number by an argument of no little consequence. This argument refers to the systematic position of the Keratosa in the whole group of Porifera, and it appears to me that a detailed discussion of this question will be the less superfluous, as the corresponding conclusions promise to be not only of theoretical importance but also of practical applicability. There are mainly in practice two different methods of systematic procedure. The usual one is to begin with lower systematic unities, in order to ascend to families, orders, &c. With respect to many other instances

the matter is quite different, and it depends very often exactly on our conceptions as to whether the given group forms a class or a family whether we subdivide it directly into genera or preliminarily into orders and suborders. Now we have seen that there exist in science quite opposite opinions as to what the genus ought to represent, and that many naturalists find no absolute distinction between genus and species. We have also seen that in the Keratosa, to use the words of Prof. F. E. Schulze,[1] "die Entscheidung der Frage, ob eine Anzahl verwandter Formen als Arten einer Gattung oder als Varietäten einer Art hinzustellen sind, oft besonders schwierig erscheint." Be that as it may, the given forms must be classified and introduced in the system, and the hesitation of the classifier must come to an end. On what now may his final decision depend? That it may depend on the inspiration of the moment is undeniable, but I think the importance of this latter factor must not be exaggerated. Every conscientious investigator will always search for more positive arguments, and it is plain that if he regard the corresponding group as an order subdivisible into families, he will bring his hesitation to an end by creating a new genus; and, on the contrary, if he believe the group to be only a family, he will describe the series of forms in question as a species with varieties. Accordingly, and as I remarked before, from *this* point of view a reliable answer to the question put on the preceding page is the most desirable.

Numerous and very conflicting opinions have been expressed on the problem of the affinities of the horny sponges. I begin with that of Oscar Schmidt. This naturalist does not deny the close relationship of his Ceraospongiæ with the Monactinellida, and namely with Chalinidæ, moreover, he regards them as forming no larger systematic unity than a family; but he considers[2] them to present an independent natural group, and is decidedly against any introduction of true Chalinidæ into it. Hyatt goes still further. He regards the Keratosa as forming an independent order, a very significant statement, since the naturalist just named, when writing that "the characteristics of the order Keratosa are more clearly defined than those of any other among the class Porifera," &c. (Revision, &c., vol. i. p. 399), was of the opinion that the whole group of Porifera form nothing more than a class of Infusoria.[3] There are in his valuable memoir on the North American Porifera no further explanatory observations in this direction, but it is plain that the words above quoted admit of but one explanation, namely, that the Keratosa are to be regarded as a group systematically equivalent to the groups Calcarea and Silicea. Gray[4] and Bowerbank,[5] in harmony with Grant, call the Keratosa also an order, but they class within it the true horny sponges with sponges producing "proper spicules." Finally, Carter,[6] agreeing on the whole with Gray and Bowerbank, differs from them in this point, that he considers the Keratosa to represent two orders, without forming,

[1] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 612.
[2] Spong. d. adriat. Meeres, II. Suppl., p. 9; Spong. d. Küste v. Algier, p. 36.
[3] Revision, &c., vol. ii. p. 481.
[4] *Proc. Zool. Soc. Lond.*, 1867, p. 503.
[5] Monograph Brit. Spong., vol. i. p. 205.
[6] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xvi., 1875, p. 132.

however, an upper group. This latter statement demands an explanation. The fact is that Carter does not follow the, so to speak, "dendroid" principle of classifying Porifera recommended by Gray; he does not adopt his subdivision of Porifera into two chief groups, that of Calcarea and that of Silicea,[1] but subdivides the whole type or subtype of Porifera into eight equivalent groups (orders), leaving the reader entirely uncertain how the mutual affinities of these eight orders are to be graphically expressed,—whether by eight radial branches from the same spot, or by one chief branch with secondary, tertiary, &c., ramifications. I lay great stress upon this. Our present aims are not only of purely systematic, but also of phylogenetic, character, and the more the most experienced spongiologist of our day, Mr. Carter, has the right to express his opinions on the question, the more one must feel disappointed to find in his system an arrangement which, neglecting the usual laws of the systematic, and yet not accompanied with an explanatory genealogical tree, leaves the reader in the mist of uncertainty as to whether its author regards, *e.g.*, the Calcarea as forming a group systematically equivalent to that, for instance, of Psammonemata, the Ceratina equivalent to the Hexactinellida, &c., or not. Apart from these more general questions, the opinions of Mr. Carter as to the affinities of horny sponges are clear; in harmony with Gray and Bowerbank he composes his third family of Psammonemata (Pseudohircinida) of groups devoid of proper spicules and again of groups provided with them. The opinions of different spongiologists as to the question I am now discussing are thus very contradictory and even conflicting, but although most of them are expressed in very decided language, it would yet be a hopeless task to search into their papers for any grounds in favour of suggestions upheld by them; these grounds are shrouded in darkness. Moreover, the decided language just alluded to is often at variance with other suggestions of the same author. Thus, for instance, with respect to O. Schmidt. On page 36 of his work on the sponges of Algeria he lays stress on his Ceraospongiæ and Chalineæ being quite natural and independent families; on the following page of the same work he says that he feels certain that "gewisse Gattungen einer Chalineæ zu nennenden Familie unter sich weit weniger als mit bestimmten Gattungen der Ceraospongiæ, direct verwandt sind." Under such circumstances there remains no other way of elucidating the matter but to turn to

[1] Dr. Vosmaer (Report on the Sponges dredged by the "Willem Barents," p. 3), agreeing with this proceeding, but not content with the designation of Silicea, since it embraces forms like true Keratosa or Myxospongiæ, *i.e.*, forms devoid of any siliceous spicules, proposes for it the name of "Non-calcarea." I believe this to be scarcely an amelioration. There are indeed cases when negative designations are very fortunate. On the whole, however, they are not to be recommended, and certainly not with respect to the Non-calcarea of Vosmaer. The name of, *e.g.*, *Acrania*, Haeckel, being negative, includes nevertheless a systematically important positive allusion. That of Non-calcarea is devoid of it. I agree that it is illogical to call Silicea *inter alia* sponges without any siliceous spicules, but though illogical this designation is in possession of a phylogenetic sense. As the reader will see later, there can be no doubt as to the fact that Keratosa, like Myxospongiæ (these latter perhaps not directly, but this does not alter the case), owe their origin to siliceous sponges, and from this point of view there can be no objection to the grouping of all these closely allied sponges under the general name "Silicea"—as nobody finds it strange that the order of Diptera includes forms like *Pulex irritans* or the type of Arthropoda animals like *Rhizocephala* or *Tardigrada*.

the actual data, viz., to the differences in structure distinguishing the horny sponges from other Silicea. The usual and natural characteristic of the Keratosa is the following:—Porifera with horny skeleton devoid of proper (siliceous) spicules. This diagnosis alludes to this, that there must exist amongst Silicea, sponges although provided with a true horny skeleton, yet characterised by the possession of spicules produced by the sponge itself. This allusion concerns the groups of Silicea known under the name of Chalinidæ, whose main systematic character consists in the possession of a horny skeleton recalling as to its external structure that of true Keratosa, but rich in horny substance as it is, yet containing within its fibres proper spicules enclosed. Now through the genus *Chalinula*, O. Schmidt, the Chalinidæ are most closely allied to typical Monactinellida. There are accordingly between a typical horny sponge and a typical Monactinellid long series of intermediate connecting stages, and their existence proves that the Keratosa and Monactinellida must have had the same phylogenetic origin. This has never been disputed; and, on the whole, it is in thorough harmony with embryological data also. The larvæ of Keratosa as described by Barrois[1] (*Verongia* [*Aplysilla?*] *rosea*) and F. E. Schulze (*Euspongia officinalis*,[2] *Spongelia pallescens*,[3] *Aplysilla sulphurea*[4]) and those of *Chalinula fertilis* and *Reniera filigrana* as described by Keller[5] and Marshall,[6] as well as their previous and probably further development, admit of no absolute distinctions. Indeed, while the usual mode of division of the ovum is equal, that of the ova of *Chalinula* is, according to Keller, unequal. But, firstly, this difference is of a very subordinate nature, and, secondly, it is still questionable whether this statement of Keller is more reliable than his suggestion as to the sexual dimorphism of the species in question. There can be, I repeat, no doubt as to the Keratosa and Monactinellida having had the same origin. But the matter, indisputable as it is, can be interpreted differently. The genealogical tree accompanying the paper of Prof. Schmidt on the sponges of Algeria (*loc. cit.*, p. 35) shows that this naturalist considers the Keratosa to be an older group than the Monactinellida, to represent, namely, a group from which the true Silicea have originated. If this be true, the systematic proceeding of Hyatt I have spoken of a couple of pages before would receive a thorough sanction, and the class of Non-calcarea, Vosmaer (for in such a case the designation of Silicea applied to the group by Gray would be no longer admissible), would require to be subdivided into two orders, Keratosa and Silicea. This suggestion is, however, far from being reliable, and a short deliberation renders it obvious. I ask what appears more easily and naturally realisable, the transformation of a Siliceous into a Keratose sponge, or *vice versa* of a Keratose sponge into a Monactinellid. I think there can be no doubt as to the answer. In the species *Chalina limbata*, Bk., we have to do with a sponge whose skeletal fibres are extremely poor in proper spicules; an insignificant

[1] *Ann. d. Sci. Nat. (Zool.)*, sér. 6, t. iii., 1876, p. 56.
[2] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 642.
[3] *Ibid.*, Bd. xxxii. p. 144.
[4] *Ibid.*, Bd. xxx. p. 414.
[5] *Ibid.*, Bd. xxxiii. p. 317.
[6] *Ibid.*, Bd. xxxvii. p. 221.

quantity of them is, however, still to be found. Are these spicules to be regarded as physiologically functional, however it may be? Can we assume that a single row of siliceous spicules render the horny fibres of *Chalina limbata* more hard? Can we ascribe to them any other than phylogenetic significance? Of course not; and, on the other hand, it is also plain that a sudden apparition of spicules in the horny fibres previously devoid of them is thoroughly inexplicable. On the contrary, the substitution of a horny skeleton for a skeleton represented by siliceous spicules is very simply imaginable. In numerous Silicea we have to deal with forms whose siliceous supporting apparatus forms throughout a network in the proper sense of the word. In many other Silicea we meet with forms whose skeleton is represented by spicules lying exclusively isolated; there are again amongst them forms whose skeleton is constituted by spicules aggregated in rows. That a skeleton represented by a compact network is of a firmer build than a skeleton represented by spicules lying isolated is evident. From this point of view it becomes clear that had a sponge once received the faculty of cementing the rows of its spicules with any connecting substance, this acquirement would have proved to be of a great profit to it. It is also equally plain that if the cementing substance proved to be equally hard and steadfast, and at the same time more elastic than the siliceous spicules, it might, in the course of time, have forced away these latter entirely. I hope this theory gives a very simple explanation of the phenomenon. It is also in harmony with the facts concerning the structure of the soft parts of Keratose sponges, and, on the other hand, of Chalinidæ, Renieridæ, &c. Of course the literature of the question is very poor; some remarks of Dr. Vosmaer[1] on the structure of the Renieridæ, as well as a couple of observations on the anatomy of the Chalinidæ by Dr. Keller;[2] the observation of this naturalist[3] on the structure of *Reniera semitubulosa* executed under the influence of Prof. Haeckel's statements on the non-existing racemose type of the canal-system being unreliable; they are, however, quite sufficient for our purposes, and with regard to the Renieridæ I can also make use of my own investigations. As to the Chalinidæ, the drawing by which Dr. Keller illustrates the internal organisation of his *Chalinula fertilis* (*loc. cit.*, pl. xviii. fig. 1) cannot be misinterpreted; the ground-mass being devoid of any granules, and the flagellated chambers of special cameral canaliculi, it is clear that we have here to deal with the type of the canal-system characteristic of Spongelidæ, and the size of the flagellated chambers being, according to Keller (*loc. cit.*, p. 327), 0·02 mm. on an average, and their shape round, with that special modification which distinguishes my genus *Psammoclema*. As to the internal structure of Renieridæ, I differ somewhat from Dr. Vosmaer. Indeed, his remarks are extremely short. He states, however, that their anatomical organisation recalls vividly that of *Euplectella aspergillum*, as

[1] Voorloopig berigt omtrent h. onderzoek aan de Nederl. werktafel in h. Zoöl. Stat. te Napels, Haag (?), 1881.
[2] *Zeitschr. f. wiss. Zool.*, Bd. xxxiii. p. 326.
[3] *Ibid.*, Bd. xxx. p. 579.

described by Prof. F. E. Schulze.[1] Now, so far as the delicate construction of Renieridæ is concerned, I can but confirm Dr. Vosmaer's statements as to the striking resemblance of these Monactinellida with *Euplectella*. Prof. Schulze lays stress, however, also on the fact that in *Euplectella aspergillum*—and as he told me in Hexactinellida in general—the flagellated chambers are comparatively very large, and, in appearance, typically pouch-shaped, recalling the radial tubes of the Syconidæ. In the species of *Reniera* I had for examination, *Reniera aquæductus*, *Reniera filigrana*, *Reniera semitubulosa*, *Reniera fibulata*, and two or three Renieridæ not determined, I found their flagellated chambers to be always of *roundish* outline, therewith not larger, or at least but little larger, than those of, *e.g.*, *Psammoclema vosmaeri*. I would be, however, scarcely right to lay stress on the contradiction in question, for, firstly, it is but too possible that there are representatives of the genus *Reniera* with radial tube-like flagellated chambers, and, secondly, the differences between flagellated chambers of this kind and those characterising my genus *Psammoclema* are of a thoroughly quantitative nature. At any rate, it is clear that, so far as the Monactinellida, the most closely allied to the Keratosa, are concerned, they are characterised by an arrangement of the canal-system of a more primary character than that distinguishing the majority of the Keratosa. Is this not an evident proof that they are to be regarded as palæontologically older sponges?[2] I think all these circumstances together speak so decidedly for the supposition I am now asserting that the matter can be regarded as scientifically proved. This deduction is of great consequence, for under these conditions there are absolutely no grounds for regarding the group of Keratosa as an order, *i.e.*, a systematically higher unity than the families Chalinidæ, Renieridæ, &c., the more so as it is even impossible to say that Keratosa are less closely connected with Chalinidæ than these latter with the Renieridæ. Of course the thorough absence of proper spicules in their skeletal fibres admits of their very sharp diagnosis, while the diagnoses of Chalinidæ and Renieridæ are of a more conditional nature; but who can warrant that the genus *Spongelia* is in closer relationship with *Euspongia* than with *Chalina*? who can guarantee that the relative characters distinguishing *Spongelia* from *Euspongia*, and concerning the internal organisation of the soft parts, are of less importance than the equally quantitative distinctions concerning the properties of the skeleton differentiating the

[1] *Trans. Roy. Soc. Edin.*, vol. xxxix., 1880, p. 661.

[2] The type of canal-system characterised by an entire absence of special cameral canaliculi, and by clearness of the ground-mass surrounding the flagellated chambers, can be regarded as characteristic of Monactinellida in general. Apart from the Renieridæ above mentioned, I can state this with respect to the following forms I had the opportunity of examining—*Suberites domuncula*, N.; *Esperia bauriana*, O. S.; *Myxilla rosacea*, Lbn.; *Myxilla veneta*, O. S.; *Raspailia viminalis*, O. S.; *Acanthella acuta*, O. S.; *Axinella polypoidæs*, O. S. On the contrary, the canal-system of the representatives of the genus *Papillina*, O. S. (*Papillina suberea*, *Papillina nigricans*), is not less highly developed than that of *Aplysina aërophoba* or *Corticium candelabrum*; but it must be added that the genus *Papillina*, although undoubtedly closely allied to the genus *Suberites*, seems also through the genus *Osculina*, O. S., to be still more closely connected with the Chondrosidæ, and may, together with these latter, represent a family palæontologically not less recent than that of Ceraospongiæ.

Spongelidæ from the Chalinidæ? Indeed, the most simple procedure is to adopt the Keratosa as an independent group; but it should not be overlooked that this procedure is nothing more than the concession to our natural wish to have for the groups we establish the sharpest possible diagnoses.

I should like to summarise my conclusions. We have seen that the subdivision of the Keratosa into two orders is inadmissible; we have seen that their subdivision directly into families gives also as results families of a very ambiguous nature. After the above deduction we can but say that all this is very comprehensible, *since the whole group is nothing more than a simple family.* Of course, as is the case with the subtype of *Acrania*, a high systematic subdivision can be represented by a simple family; and, on the other hand, as is the case with, *e.g.*, Terebellidæ, a family can be subdivided into numerous subfamilies, these latter consisting again of generic unities. This latter measure finds, however, its application in exceptionally rare cases, and only then when it is really necessitated by the richness of the forms as well as by the richness of systematic characters, and, on the other hand, by higher phylogenetic considerations, while the immediate purpose of my foregoing discussion consisted precisely in the attempt to prove that it is due exactly to the erroneous opinion that Keratosa forms a systematically high subdivision, that naturalists split them into orders, suborders, and families. Of course, it cannot be denied that certain genera established in them are more closely connected one with another than with the remaining representatives of the group. This would be, however, only of consequence if all the genera in question were homogeneous, while in reality some of them are undoubted genera, the others perhaps but species. This is the gist of the matter, and I think that the only natural reconciliation of all these contradictions can be obtained by rendering our genera equivalent one to another, which can be realised by enlarging the idea of genus, *e.g.*, by uniting forms, distinguished as *Hippospongia*, *Euspongia*, &c., in the single genus *Spongia*, which would be, on the whole, thoroughly equivalent to the genus *Ianthella* or *Darwinella*. But if the species constituting the conjectural genera *Hippospongia* or *Stelospongos* are yet undoubted species? I answer, prove that they are so, and in that case subdivide the genus *Spongia* into corresponding *subgenera*. As is well known, these latter systematic unities are out of use; I regard, however, their introduction in systematic practice to be equally profitable for systematic purposes in general, as well as with respect to the special case of classifying the Keratosa in a tolerably natural manner. I opened my "criticism of the genera" with a comparison of different opinions as to the value of generic distinctions, and we have seen that in this respect diametrically opposite ideas have been expressed by different naturalists. The word "diametrically" just used alludes to the impossibility of their thorough reconciliation; the introduction of subgenera in zoological calculations would reconcile them at least so far as this is possible, and again it is obvious that sooner or later this reconciliation must be realised, since neither the opinions of Nägeli

nor those of his opponents can be adopted without amendments. As to the suggestion that generic distinctions must be of an absolute character, of course the acquiescence in this demand would place the creation of genera beyond the discretion of classifiers, and thus expel for ever from Science the disputes as to whether this group is to be regarded as a species or as a genus; it is however evident that, strictly and exactly prosecuted, this demand would lead to the most strange and unnatural systematic arrangements. Following it we should be obliged to unite all the Keratosa, with the exception of the genera *Ianthella*, *Darwinella*, and perhaps *Psammopemma* with all Chalinidæ, Renieridæ, perhaps all Monactinellida into a single genus systematically equivalent to that of *Darwinella* or *Ianthella*. For there are no absolute distinctions between *Chalina* or *Reniera* and *Spongelia*, and there are no absolute distinctions between *Spongelia* and *Euspongia* and *Aplysina*, and again there exist such distinctions between most of the Keratosa and Monactinellida on one hand, and *Ianthella*, *Darwinella*, and *Psammopemma* on the other. On the whole, what Prof. Nägeli recommends is applicable only to the palæontologically old groups of plants and animals. But it is not less evident that an unlimited discretion as to the creation of genera would render any systematic progress impossible; to those who feel disinclined to agree with me, I can but recommend an attentive perusal of spongiological systematic literature. The using of a varietal character, as of generic value, conditions the establishment of new apparently highly interesting and deviating species out of forms representing nothing more than by no means instructive varieties, if not individuals of very common species belonging to another genus. It is quite possible that I have myself committed the same mistake, having adopted F. E. Schulze's genus *Hippospongia*, and created a new species *Hippospongia mauritiana*, while this conjectural species is very possibly nothing but a variety or subspecies of *Spongia* (*Euspongia*) *lapidescens*. Both these opinions cannot thus in their entire extension be adopted. In my paper on the Challenger Calcarea an attempt to reconcile them has been made. Whilst subdividing this group into genera I called attention to my intention to execute this task according to the whole of their organisation, by taking into consideration all their organs in their mutual correlation; and with respect to the group just mentioned the carrying out of this principle met no difficulties, and I hope that the genera I have there established are really natural and adoptable. But there are very often cases when such a proceeding is impossible, when large groups of forms differ from one another only in a single character, the conjectural specific distinctions being in one group complete analogues to those in the other. To similar instances the principle I have followed in my above named paper is not applicable, and for my own part I see no other issue but to recommend for such cases the adoption of the scheme of Nägeli, and this in order to protect the establishment of genera so far as possible from the vagaries of classifiers, so that generic unity might serve as a firm basis, which has been wanting in descriptive zoology since the mutability of species was actually proved.

As I remarked before, the realisation of this demand necessitates the introduction of subgenera; and I am the more in favour of this because otherwise I see absolutely no possibility of arranging the Keratosa in a manner not conspicuously artificial, while in the contrary case we should obtain a very natural family of Ceraospongiæ with the following quite homogeneous genera:—*Ianthella*, *Darwinella*, *Simplicella* (with two subgenera *Aplysilla* and *Dendrilla*), *Spongia* (embracing forms classed now in the conjectural genera *Euspongia*, *Hippospongia*, *Cacospongia*, *Stelospongos*, and *Coscinoderma*), *Phyllospongos* (with subgenera *Phyllospongia* and *Carteriospongia*, provided that these subgenera are really in a close relationship), *Spongelia* (with subgenera *Dysidea* and *Psammoclema*), *Psammopemma* (supposing that this conjectural genus be not connected with *Spongelia* by intermediate stages), and *Velaria* (including forms referred at the present time to *Aplysina*, *Verongia*, and *Luffaria*, which may perhaps all be elevated to the rank of subgenera); and it is clear that each of these genera either admits of a very sharp diagnosis or evidences its right to be regarded as a genus by series of characters concerning the whole of the organisation. If now the question be asked, why instead of following, in the descriptive part of this memoir, the scheme just exposed, I have yet followed the arrangement of Dr. Vosmaer, the answer will be because the above scheme only partly decides the problem of a natural arrangement of horny sponges, and I myself am of opinion that when new systems are proposed they must be well established in all their parts. The reader will remember that in the foregoing three chapters we met with a large number of contradictions issuing from the present mode of classifying the Keratosa. The scheme in question reconciles most of them; it does not do so, or at least but partly, with respect to what I called *circulus vitiosus*, characterising the mutual affinities of the genera of the group. This *circulus vitiosus* is striking as concerning the genera belonging to different families; it has, however, equally little right to exist as concerning the mutual relationships of the subgenera. It would have been very easy to proclaim the Keratosa as forming but a single family, and to classify according to this the specimens of the Challenger Collection; but by this proceeding we should not have got rid of difficulties concerning questions of course of a more subordinate nature but nevertheless of vital importance; this proceeding would not have decided the problems as to whether subgeneric value can be really ascribed to the characters distinguishing the *Hippospongiæ* or *Coscinodermata*, &c. This is the second, and the most difficult part of the task, and without the help of Palæontology and Comparative Physiology it will be scarcely decided. As must be evident from the above discussions, by the term "subgeneric character" I understand a character containing in it a new principle of organisation, the corresponding representatives of the group being connected by intermediate stages. That *Euspongia*, *Cacospongia*, *Hippospongia*, &c., present each in their organisation what may be called a new principle is clear; but it is by no means evident whether this, their conjecturally main character, be really constant. Should we feel certain that the fossils described as

horny sponges do really belong to the Keratosa, that, *e.g.*, *Dysidea antiqua*, Carter,[1] from the Carboniferous system, is really a horny sponge and not a worm-tube or something of that kind, in a word, should we feel certain that Keratosa is a palæontologically old group, of course we should regard *Hippospongia*, *Euspongia*, &c., as representing each a subgenus, and pay but little attention to the existence of forms like *Velinea gracilis*, Vosmaer, or my *Cacospongia intermedia* conditioning the *circulus vitiosus* above mentioned. But this is precisely the question to be answered; it is but too possible that Keratosa is a very recent group, and in this case the many-sidedness of their affinities may be explained by their very high variability, in which case only specific and varietal importance must be ascribed to the characters we regard now as of subgeneric or even generic value. Prof. F. E. Schulze established a new genus *Oligoceras*; he told me that all specimens of his *Oligoceras collectrix* were found between stones in a position which renders the presence of a special supporting skeleton superfluous; it is to be asked whether the loss of this latter is immediately realisable or not. It is, in one word, necessary to express more or less approximatively the proportion between the stability of these and other characters and their mutability, *i.e.*, their faculty of conforming to existing influences. His genus *Hippospongia*, F. E. Schulze characterises by the presence of numerous channels, *i.e.*, cavities breaking through the body of its representatives in different directions. That this property is due to the necessity of enlarging the outer surface is perfectly clear; it is again to be asked whether this character can be adopted in a short space of time. Mr. Carter established a genus *Coscinoderma*, but with the diagnosis he gave[2] to it in his last paper the genus is not adoptable: "Sieve-like incrustation, composed of foreign bodies uniformly foraminated and continuously spread over the surface, whose evenness is not disturbed by the usual polygonal projection of the subdermal fibre. Fibre fine, woolly." Should we follow it we should have this genus represented but by the single species *lanuginosum*. I widened the diagnosis and described as *Coscinoderma* also *Coscinoderma altum*, characterised by comparatively thick skeletal fibres, in most cases cored with foreign enclosures. The type-specimen of *Coscinoderma* possesses very fine fibres, all of the same diameter; the skeletal fibres of all *Cacospongiæ* are thick, and usually overloaded with foreign bodies; they admit, however, of the distinction of primary and secondary ones. *Coscinoderma altum* has thick fibres cored with foreign bodies, but all its fibres are of the same size. Ought I to class the form in question in the genus *Coscinoderma* or in that of *Cacospongia*? Ought we to ascribe to the differentiation of the fibres into primary and secondary ones a higher systematic consequence than to their equal size? The reader who has perused my description of the Challenger specimens will find there such alternatives at every step. And to sum up, so long as we possess no statements as to the stability of the characters of the horny sponges we shall have no natural arrangement of them. There

[1] *Ann. and Mag. Nat. Hist.*, ser. 5, vol. i., 1878, p. 139.

[2] *Ibid.*, February 1884, p. 129.

was a time in Zoology when the external shape of the animals was considered quite sufficient for descriptive purposes; this period was followed by the period of, so to speak, anatomical character, naturalists discovered a new source of systematic characters in Comparative Anatomy, and believed its help to be sufficient for deciding the most complicated phylogenetic questions; the apparent success was so great that this conviction finds its echo in papers of very recent date—as for instance in v. Jhering's Monograph on the Mollusca. The time came, however, when zoologists became aware that their anatomical hopes were but illusions, and the word Comparative Embryology became the watchword of the day. That this department of Zoology also has not justified the hopes based upon it is but too well known, and the modern watchword is Comparative Physiology. Whether this study, at the present time in its infancy, will justify what it promises, will be seen later; on the whole, it is clear that in most cases not this alone but all branches of Zoology together will give us the answers we require; but in instances like that concerning the Keratosa, where almost all other lines of research are of no avail, this new science may be particularly welcome. The possibility of a disappointment is of course not excluded, and therefore further purely systematic papers on the Keratosa are of course very desirable. It would be, however, still more desirable that Science, hand in hand with this, would follow up also another way, that, namely, of Comparative Physiology. This is the immediate task to be executed, and in the case of spongiologists residing near the sea-shore it is very easily realisable.

CONTENTS.

PAGE

Introduction, ... 1, 2

I. Organisation and Classification of the Keratosa, ... 2–20

Prefatory Remarks, ... 2

Systematic Value of Skeletal Fibres, whether Homogeneous or Heterogeneous, . . . 3

Systematic Value of Skeletal Fibres, whether Cored with or Devoid of Foreign Bodies, . . 9

Systematic Value of the Peculiarity of Skeletal Fibres characteristic of *Ianthella*, . . 11

Systematic Value of the Presence of Filaments, ... 12

Systematic Value of the Properties of the Canal System, ... 16

Corollaries, ... 18

II. Criticism of the Genera, ... 21–35

Darwinella, ... 21

Aplysilla, ... 22

Dendrilla, ... 22

Ianthella, ... 22

Velinea, ... 23

Spongelia, *Dysidea*, *Psammascus*, ... 23

Psammoclema, ... 25

Psammopemma, ... 25

Euspongia, *Hippospongia*, *Cacospongia*, *Stelospongos*, ... 26

Coscinoderma, ... 28

Phyllospongia, *Carteriospongia*, ... 29

Oligoceras, *Hircinia*, *Ceratella*, ... 29

Luffaria, ... 32

Verongia, ... 34

Aplysina, ... 34

III. Description of the Species, ... 37–72

Darwinellidæ,

Ianthella flabelliformis, ... 37

Spongelidæ.

Spongelia spinifera, ... 41

Spongelia pallescens, ... 42

PAGE

Spongelia horrida, ... 42
Psammoclema ramosum, ... 43
Psammoclema vosmaeri, ... 44
Psammoclema foliaceum, ... 45
Psammopemma densum, ... 46
Psammopemma porosum, ... 48

Spongidæ.

Coscinoderma confragosum, ... 50
Coscinoderma denticulatum, ... 51
Coscinoderma altum, ... 52
Euspongia officinalis, var. *lobosa*, ... 53
Hippospongia anomala, ... 54
Hippospongia mauritiana, ... 55
Cacospongia levis, ... 56
Cacospongia amorpha, ... 57
Cacospongia murrayi, ... 57
Cacospongia vesiculifera, ... 58
Cacospongia procumbens, ... 59
Cacospongia dendroides, ... 60
Cacospongia spinifera, ... 61
Cacospongia tuberculata, ... 61
Cacospongia intermedia, ... 62
Cacospongia irregularis, ... 63
Cacospongia oligoceras, ... 63
Cacospongia compacta, ... 64
Cacospongia collectrix, ... 65
Stelospongos longispinus, ... 67
Carteriospongia radiata, ... 67
Carteriospongia otahitica, ... 69

Aplysinidæ.

Luffaria variabilis, ... 69
Verongia hirsuta (?), ... 70
Verongia tenuissima (?), ... 71

BATHYMETRICAL TABLE, ... 73

IV. CONCLUDING REMARKS, ... 75–85

Short Recapitulation of the Deductions of the Foregoing Chapters, ... 75
Affinities of the Keratosa and their place in the General System, ... 76
Definition of the ideas "Genus" and "Subgenus," 81
Scheme of a *Conjecturally* Natural Arrangement of the Keratosa, ... 83
Problems to be Solved in Order to Render an *Undoubtedly* Natural Arrangement of them realisable, 83

PLATE I.

PLATE I.

Ianthella flabelliformis, Pallas; natural size.

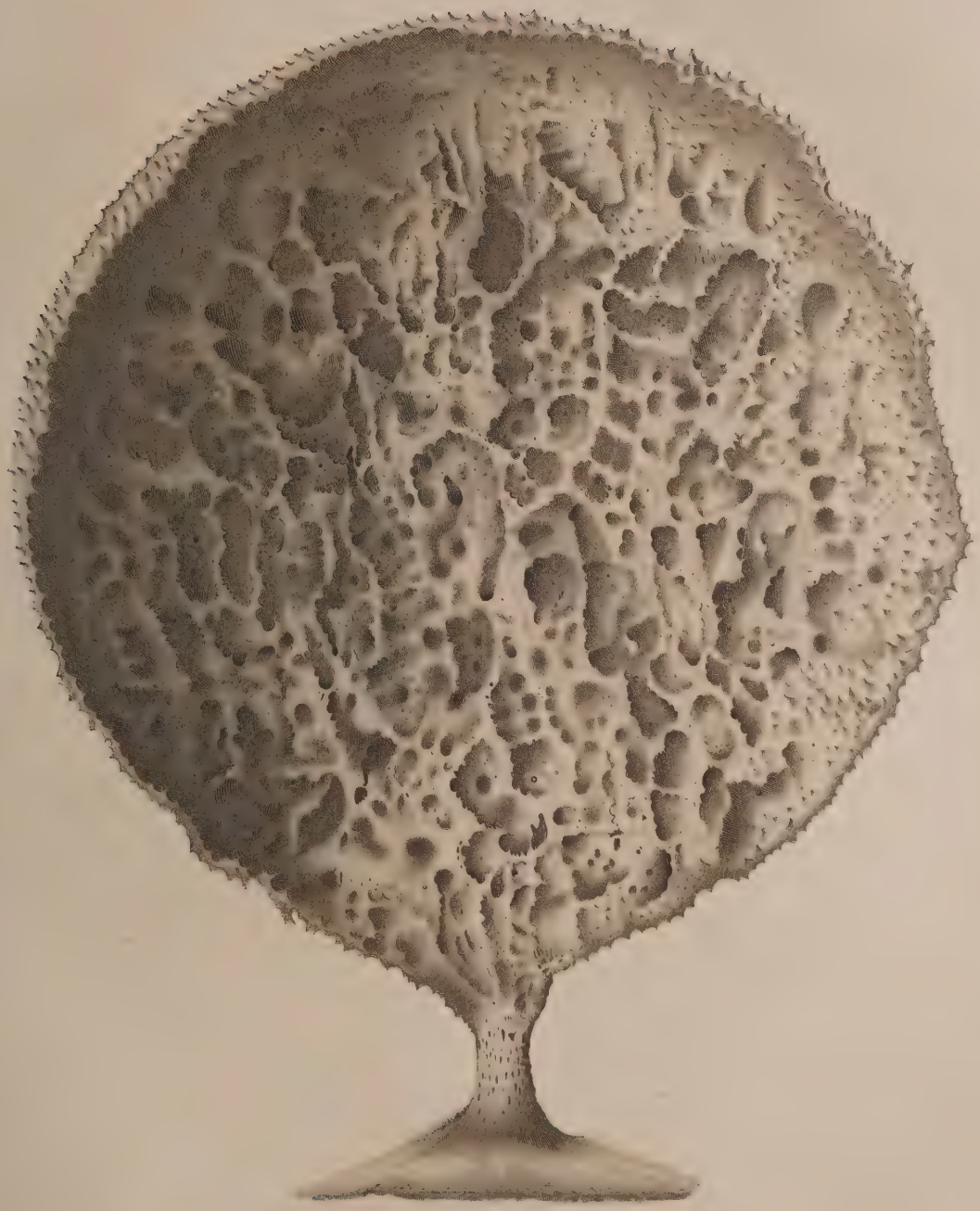


PLATE II.

PLATE II.

Ianthella flabelliformis, Pallas.

Fig. 1. Portion of the outer surface, ... × 6

Fig. 2. Portion of the skeleton of the leaf-like extension; natural size.

Fig. 3. Portion of the skeleton of the stem; natural size.

Fig. 4. Portion of a section showing the arrangement of the canal system, . × 200

Fig. 5. Portion of a section with two flagellated chambers, showing histological elements of the connective tissue,—*Am*, amœboid cells; *St*, stellate and fusiform cells, ... × 600

Fig. 6. Portion of the outer surface (from above) showing the subdermal aggregations of fusiform cells and conjectural gland-cells, . × 600

Fig. 7. Portion of a longitudinal section through the horny walls of a skeletal fibre, ... × 700

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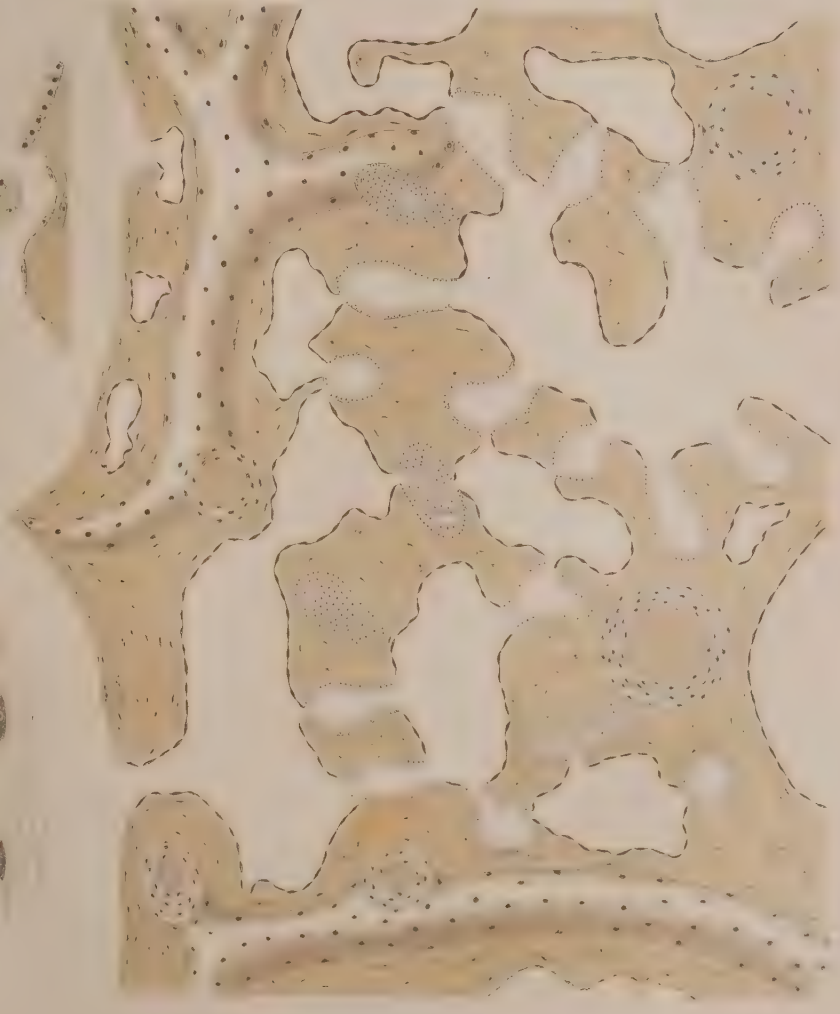

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PLATE III.

PLATE III.

Fig. 1. Portion of the skeleton of *Spongelia pallescens*, O. Schmidt; natural size.

Fig. 2. Skeleton of *Spongelia horrida*, Selenka; natural size.

Fig. 3. Fragment (?) of a specimen of *Psammopemma densum*, Marshall; natural size.

Fig. 4. Portion of a section through its body showing the form and disposition of the flagellated chambers; × 300.

Fig. 5. A colonial specimen of *Psammoclema vosmaeri*, n. sp.; natural size.

Fig. 6. Portion of a section through one of its individuals; × 300.

Fig. 7. Portion of the skeleton of *Psammoclema foliaceum*, n. sp.; natural size.

Fig. 8. The same of *Psammoclema ramosum*, Marshall; natural size.

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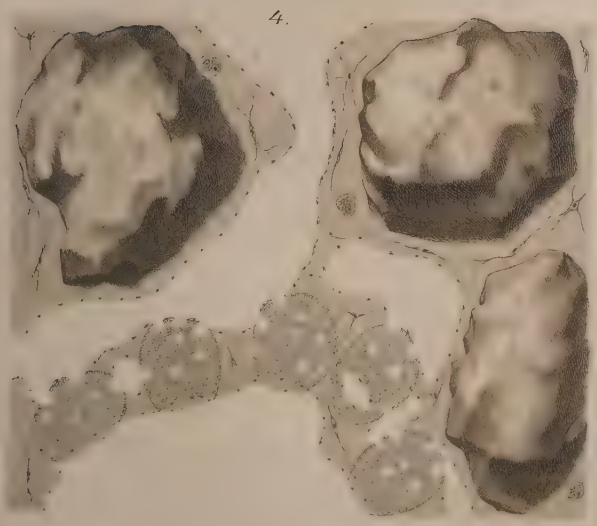
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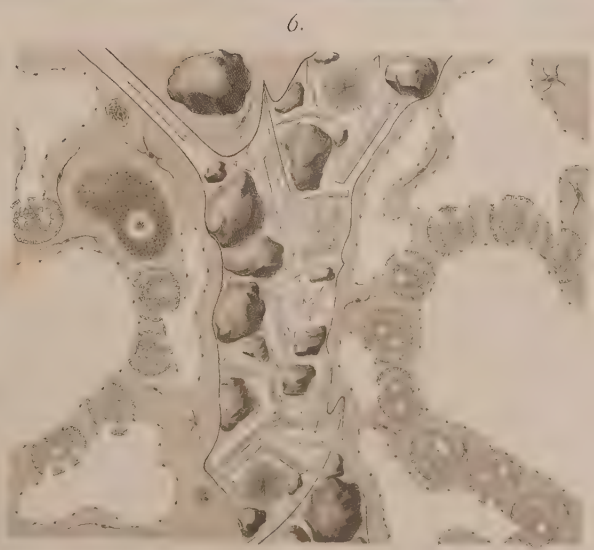
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PLATE IV.

PLATE IV.

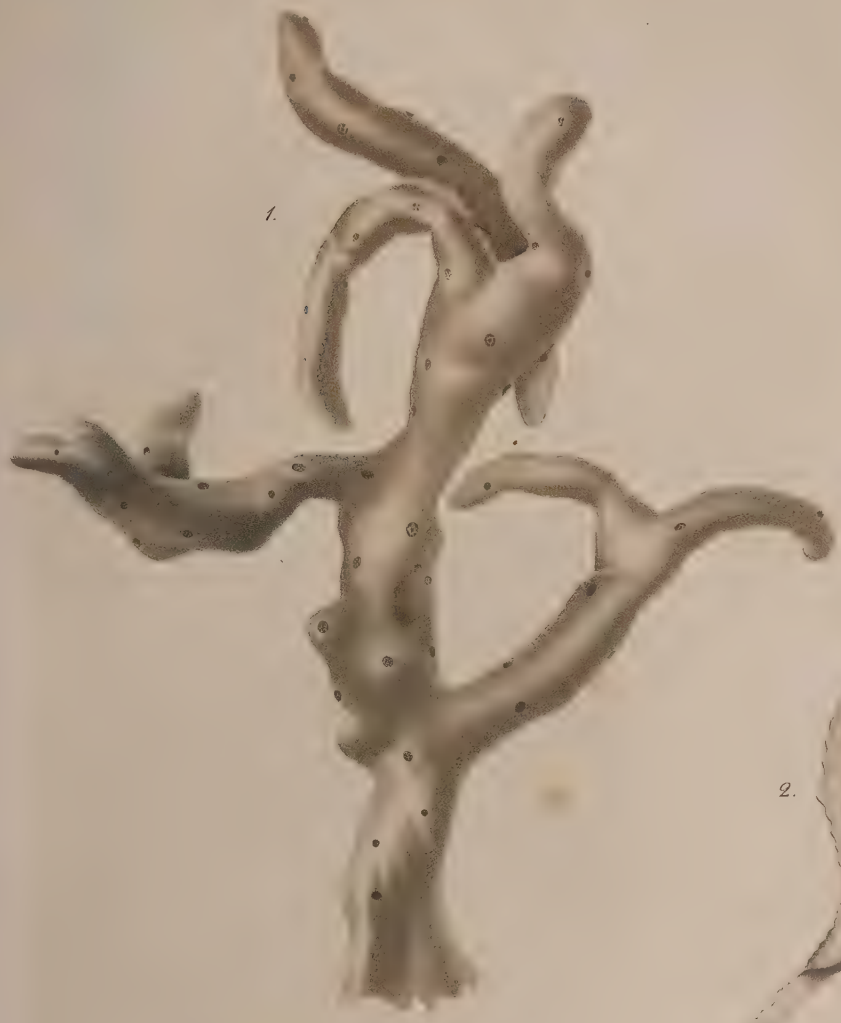
Fig. 1. *Psammoclema ramosum*, Marshall; natural size.

Fig. 2. *Cacospongia vesiculifera*, n. sp.; × 2

Fig. 3. *Cacospongia murrayi*, n. sp.; natural size.

Fig. 4. *Carteriospongia otahitica*, Esper; natural size.

Fig. 5. *Carteriospongia radiata*, Hyatt; natural size.



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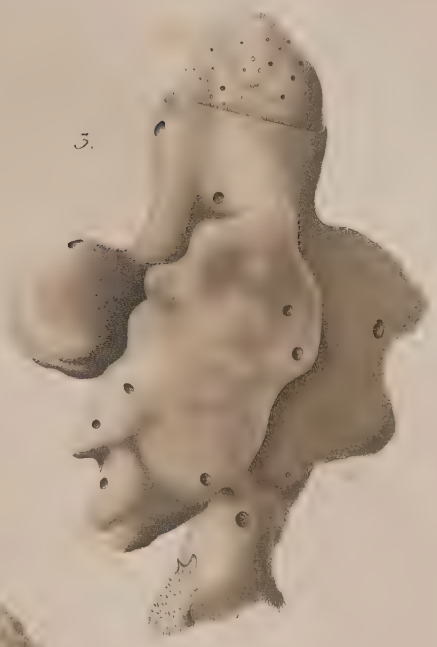

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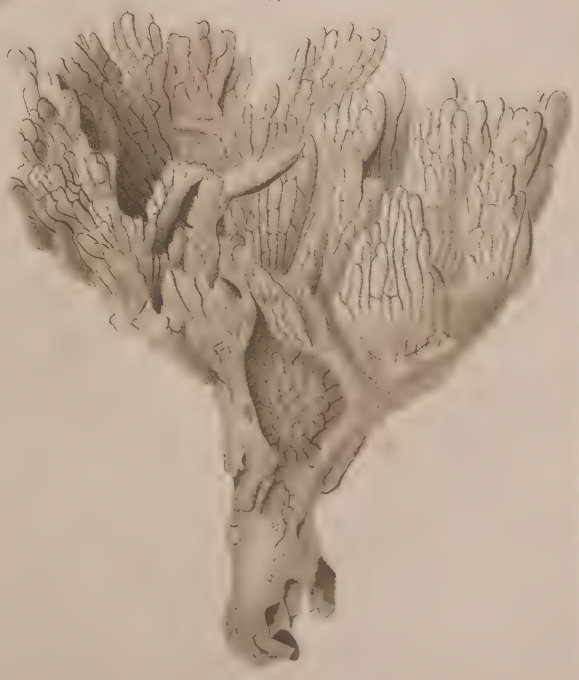

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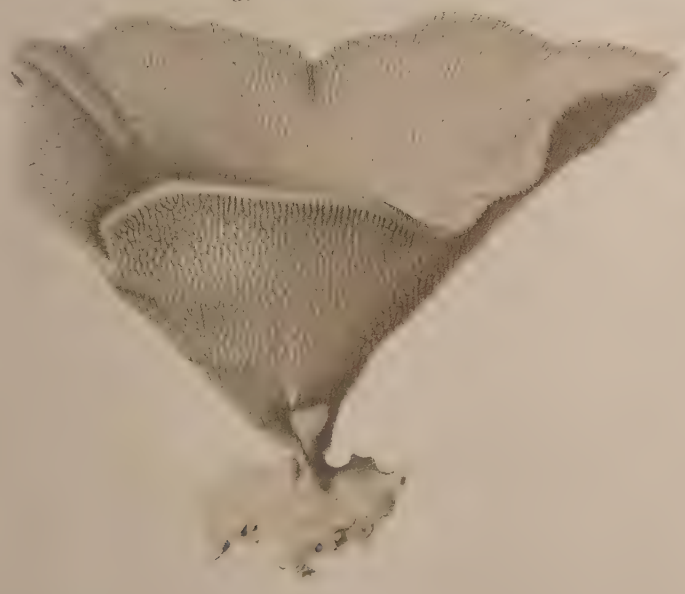

PLATE V.

PLATE V.

Figs. 1–3. *Cacospongia levis*, n. sp.

Fig. 1. Portion of the skeleton; natural size.

Fig. 2. A longitudinal section through it, ... × 4

Fig. 3. Portion of a section through parenchyma, ... × 300

Figs. 4–6. *Coscinoderma altum*, n. sp.

Fig. 4. Portion of the skeleton; natural size.

Fig. 5. A transverse section of it, ... × 4

Fig. 6. Portion of a section through parenchyma, ... × 130

Figs. 7–9. *Carteriospongia radiata*, Hyatt.

Fig. 7. A peripheral segment of the skeleton, ... × 4

Fig. 8. Portion of a section through parenchyma, ... × 300

Fig. 9. A sperm-ball and some mesodermic cellular elements, . . × 600

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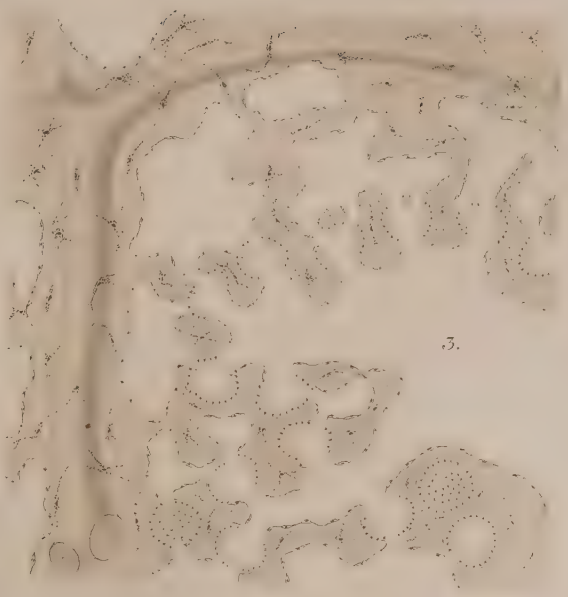

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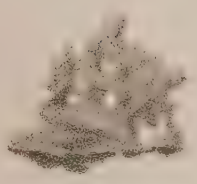

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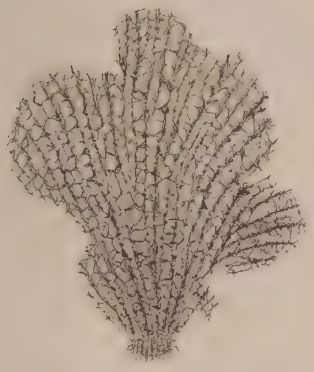

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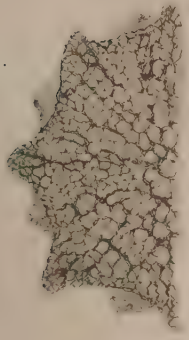

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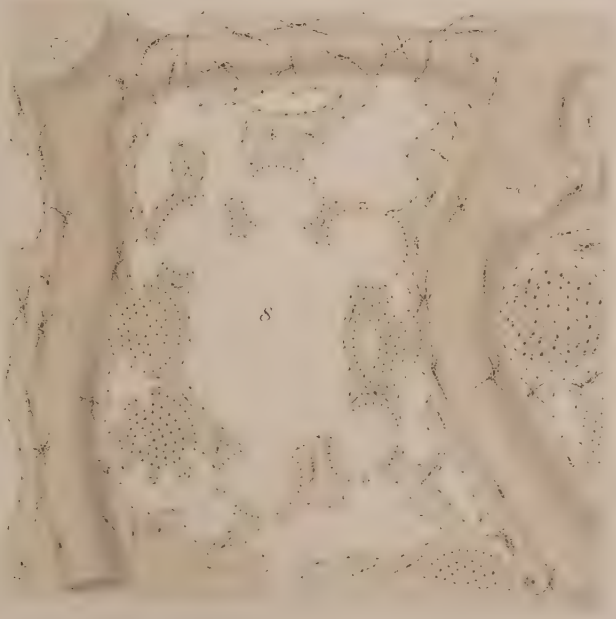

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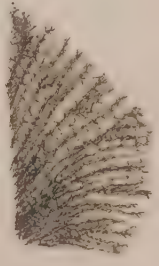


7.

PLATE VI.

PLATE VI.

Fig. 1. Portion of the skeleton of *Euspongia officinalis*, var. *lobosa*, nov.; natural size.

Fig. 2. The same of *Hippospongia anomala*, n. sp.; natural size.

Fig. 3. The same of *Hippospongia mauritiana*, Hyatt (*a*, from above; *b*, from the plane of section); natural size.

Fig. 4. The same of *Coscinoderma denticulatum*, n. sp.; × 5.

Fig. 5. The same of *Cacospongia amorpha*, n. sp.; natural size.

Fig. 6. The same of *Cacospongia procumbens*, n. sp.; × 2.

Fig. 7. The same of *Cacospongia intermedia*, n. sp.; natural size.

Fig. 8. The same of *Cacospongia murrayi*, n. sp.; natural size.

Fig. 9. The same of *Cacospongia vesiculifera*, n. sp.; natural size.

Fig. 10. The same of *Cacospongia irregularis*, n. sp.; natural size.

Fig. 11. The same of *Cacospongia compacta*, n. sp.; natural size.

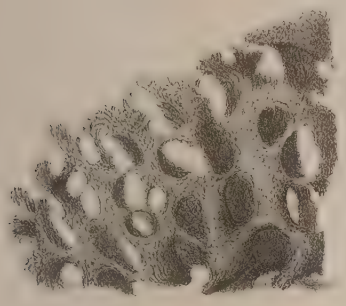
Fig. 12. The same of *Cacospongia spinifera*, n. sp.; natural size.

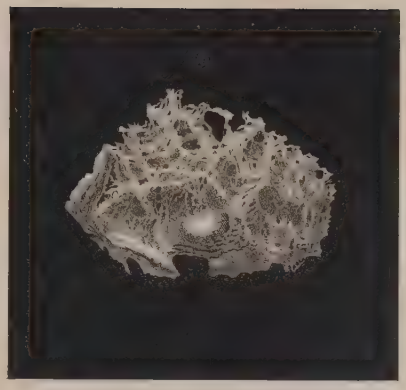
Fig. 13. The same of *Cacospongia oligoceras*, n. sp.; × 2.

Fig. 14. The same of *Cacospongia dendroides*, n. sp.; natural size.

Fig. 15. The same of *Stelospongos longispinus*, Duch. and Mich.; natural size.

2.





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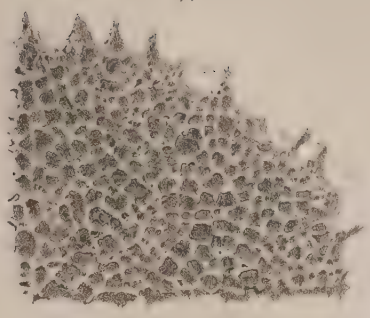

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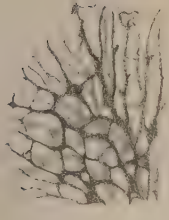

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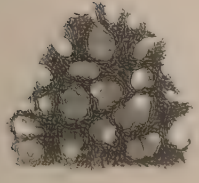

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PLATE VII.

PLATE VII.

Hippospongia anomala, n. sp.; natural size.

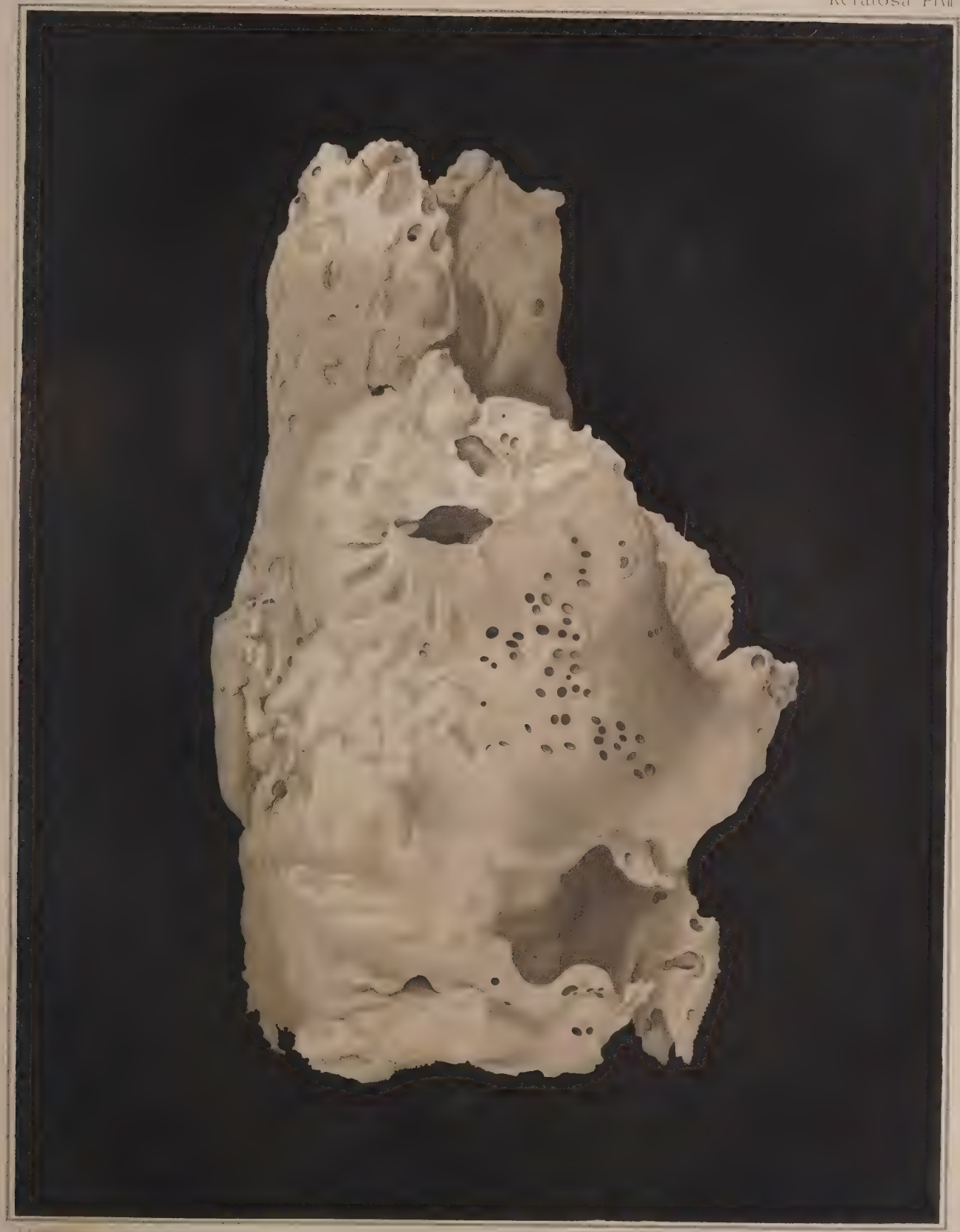

PLATE VIII.

PLATE VIII.

Fig. 1. A specimen of *Cacospongia dendroides*, var. *dura*; natural size.

Fig. 2. Portion of a section through the peripheral part of the body of *Cacospongia dendroides*, var. *friabilis*, showing numerous algoid round bodies and dumb-bell shaped corpuscles, . . . × 700

Fig. 3. A dumb-bell shaped corpuscle; highly magnified.

Fig. 4. A filament of *Stelospongos longispinus*, . . . × 400

Fig. 5. A filament of *Cacospongia irregularis*, ... × 400

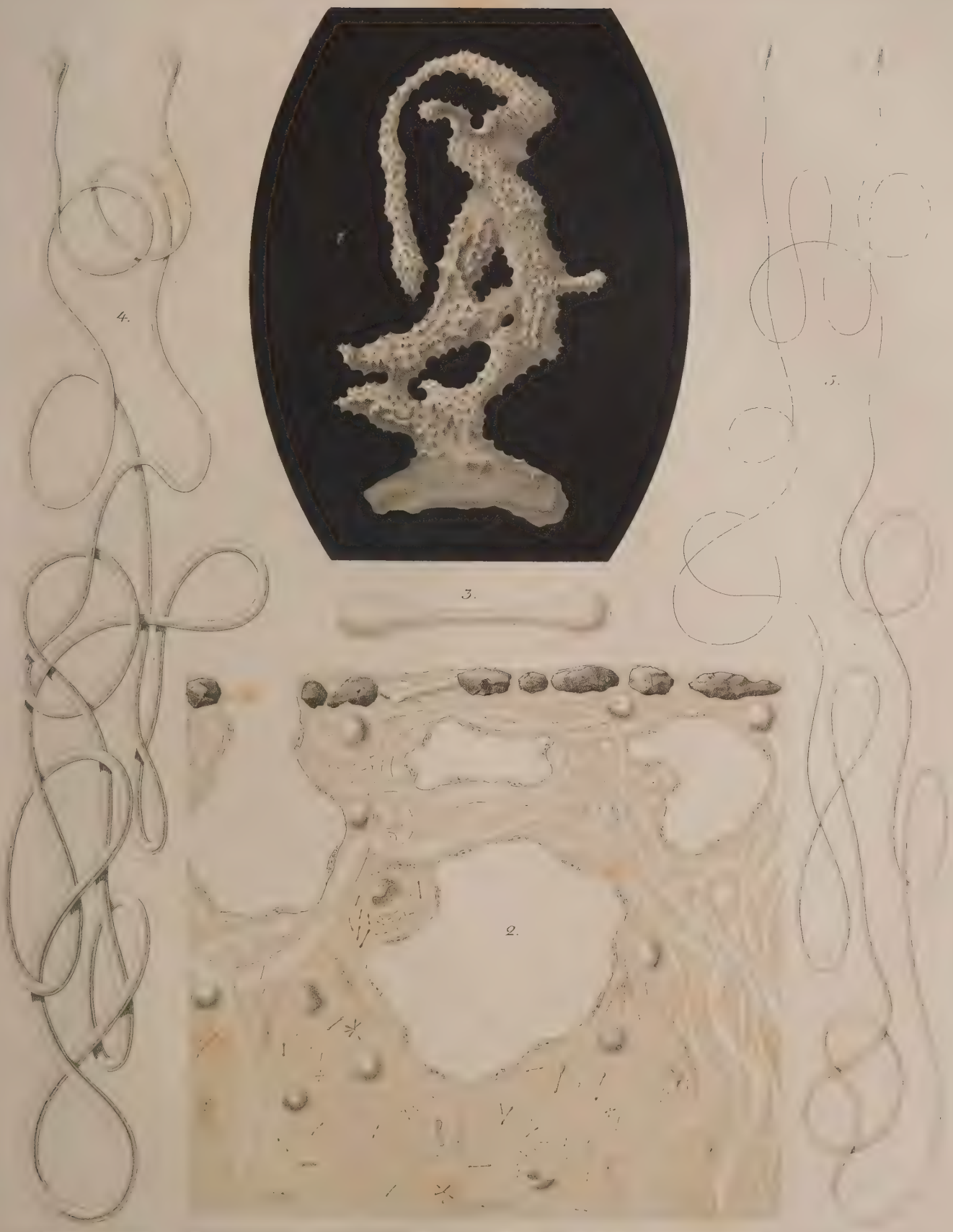
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PLATE IX.

PLATE IX.

Luffaria variabilis, n. sp.

Fig. 1. A colony of three specimens of elongated shape; natural size.

Fig. 2. Portion of the skeleton of one of them; somewhat magnified.

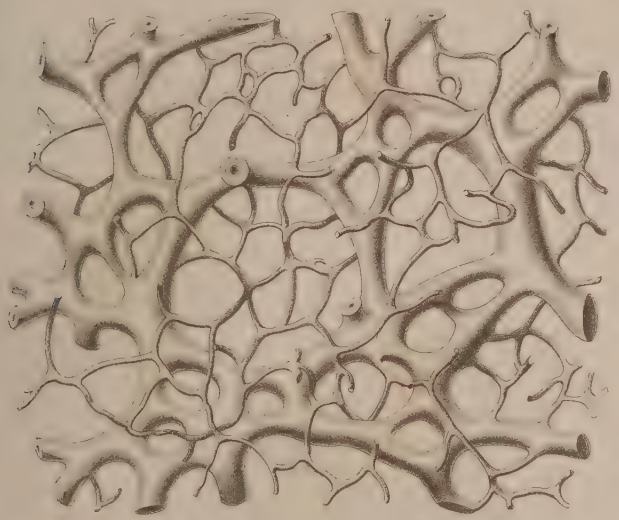
Fig. 3. A specimen of massive shape; natural size.

Fig. 4. A horizontal section through the skeleton of one of its outgrowths; natural size.

Fig. 5. Portion of this latter section; × 14.

Fig. 6. Some of the finest skeletal fibres; × 100.

5.



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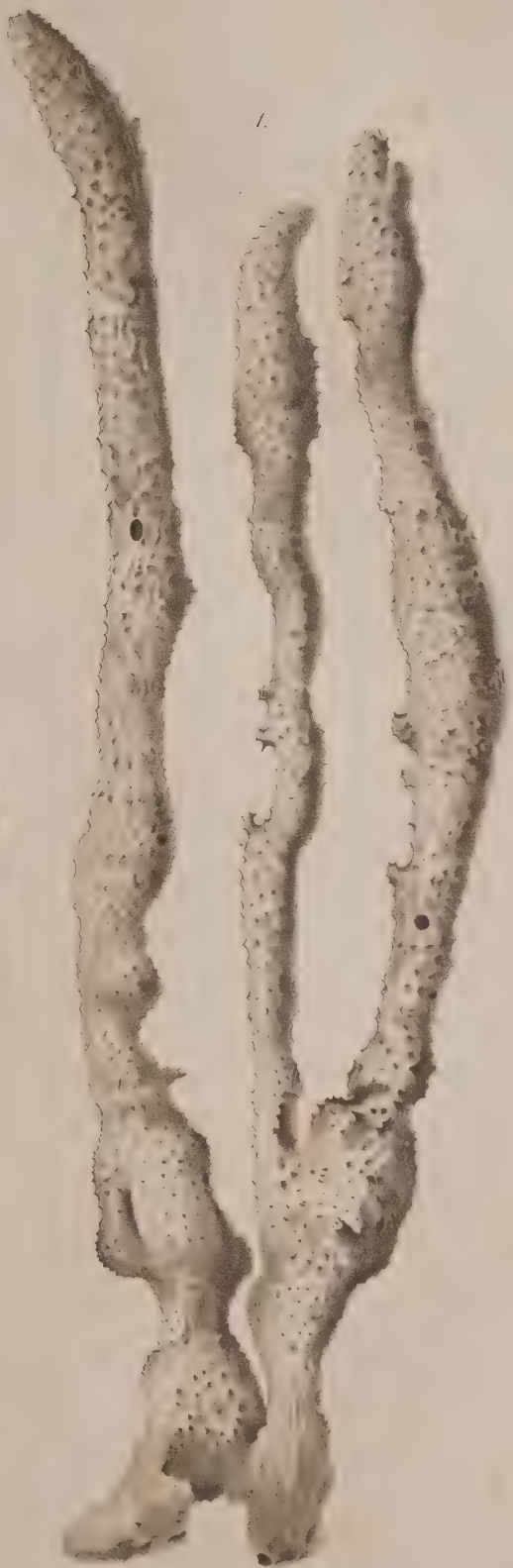

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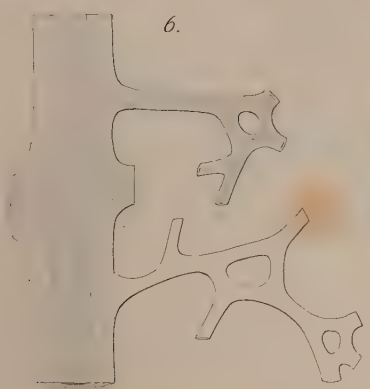

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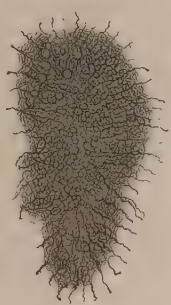

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PLATE X.

PLATE X.

Figs. 1–3. *Verongia hirsuta* (?), Hyatt.

Fig. 1. An entire specimen (the central cavity is opened by means of a longitudinal incision); natural size.

Fig. 2. Portion of its skeleton; natural size.

Fig. 3. Portion of a skeletal fibre, ... × 280

Figs. 4–7. *Verongia tenuissima* (?), Hyatt.

Fig. 4. An entire specimen; natural size.

Fig. 5. Portion of its skeleton; natural size.

Fig. 6. Pavement-epithelium of the outer surface, ... × 240

Fig. 7. Portion of a section through parenchyma, showing the arrangement of the canal system as well as the histological properties of the species,—*S*, spermospores; *R*, "Reservenahrungs-Material" formations of F. E. Schulze, ... × 600

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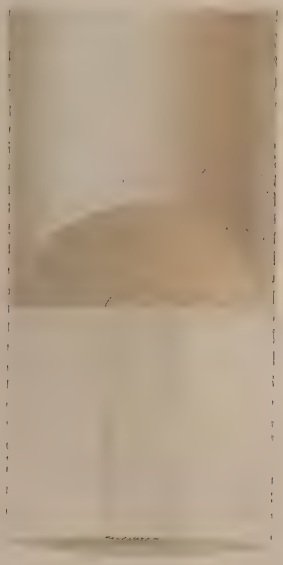

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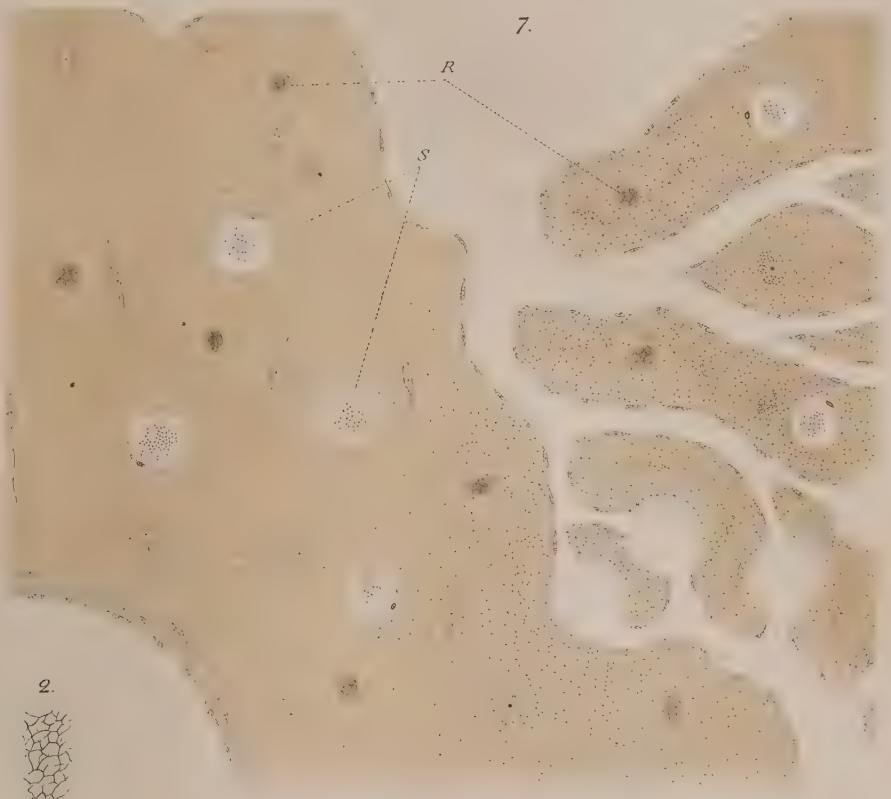

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